737-8

Flight Crew Operations Manual

Gol Linhas Aereas S.A.

Document Number MN-FLT-OH-201
Revision Number: 0 (Temporary Revision)
Revision Date: October 26, 2021

This Flight Crew Operations Manual (FCOM) has been originally prepared by The Boeing Commercial Airplanes, Commercial Aviation Services organization, and further customized to reflect GOL Linhas Aéreas S.A. fleet and flight operations.

This manual has been developed and is constantly updated based on AFM (Airplane Flight Manual).

Volume 1

Volume 2

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General

This manual applies to the 737 MAX 8 fleet operated by Gol Linhas Aéreas S.A.

737MAX series: Powered by two LEAP1B series engines. They may be equipped with advanced technology winglet, as follow:

-MAX8: 39,47m length version with up 186 passengers seat. Engine rating is 28K Package with a two position tail skid. Equipped with carbon brake.

-MAX8 EB1: 39,47m length version with up 186 passengers seat. Engine rating is 27K Package with a one position tail skid. Equipped with carbon brake.

Specific reference is made to distinguish information peculiar to one or more variant, but not all of the airplanes. Where information applies to all models, no reference is made to individual model numbers.

Systems differences are detailed in specific chapters.

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Preface — Chapter 0
Introduction — Section 2

General

This Flight Crew Operations Manual (FCOM) has been originally prepared by The Boeing Commercial Airplanes, Commercial Aviation Services organization, and further customized to reflect Gol Linhas Aéreas S.A. fleet and flight operations.

The purpose of this manual is to:

- provide the necessary operating limitations, procedures, performance, and systems information the flight crew needs to safely and efficiently operate the 737.
- serve as a comprehensive reference for use during transition training for the 737 airplane
- serve as a review guide for use in recurrent training and proficiency checks
- provide necessary operational data from the approved airplane flight manual (AFM) to ensure that legal requirements are satisfied
- establish standardized procedures and practices to enhance Gol Linhas Aéreas S.A. operational philosophy and policy.

The procedures included in this manual reflect the company policy for pilots to follow during ground operations and inflight. Deviations from these policies and procedures should be made only with good cause and bases on the safest course of action. If an abnormality occurs that is not covered by these procedures, the Captain must use his best judgment.

Manual Rights

In the event this 737 Flight Crew Operations Manual is sold or distributed to any other party, no warranty or guarantee, expressed or implied, is made as to the accuracy, sufficiency or suitability of the materials contained herein or of any revision, supplement or bulletin hereto. It is understood and agreed to by such other party that it shall release indemnify and hold Gol Linhas Aéreas S.A., its officers, employees and agents harmless against any and all claims or actions of whatever nature which may arise or claim to arise from the use hereof.

Corrections to the Manual

Any corrections to errors or discrepancies discovered in this manual should be sent via email to flightstandards@voegol.com.br

Organization

The operations manual is organized in the following manner.

Volume 1

Preface – contains general information regarding the manual's purpose, structure, and content. It also contains lists of abbreviations, a record of revisions, a list of effective pages and fleet bulletins.

Limitations and Normal Procedures – cover operational limitations and normal procedures. All operating procedures are based on a thorough analysis of crew activity required to operate the airplane, and reflect the latest knowledge and experience available.

Supplementary Procedures – covers those procedures accomplished as required rather than routinely on each flight.

Performance Inflight (PI) chapter contains information necessary for inflight use.

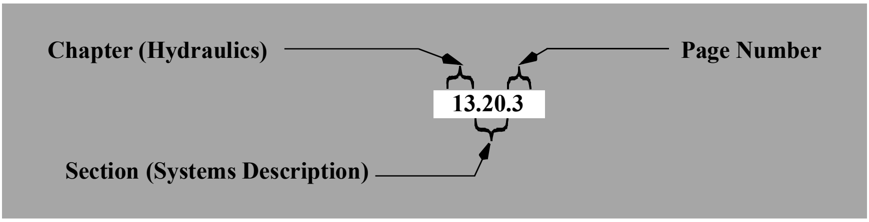
Volume 2 - Chapters 1 through 15 contain general airplane and systems information. These chapters are generally subdivided into sections covering controls and indicators and systems descriptions. Aircraft Differences chapter notes differences between aircraft types.

Quick Reference Handbook (QRH) - The QRH covers normal and non-normal checklists and shows performance tables.

Page Numbering

The FCOM uses a decimal page numbering system. The page number is divided into three fields; chapter, section, and page. An example of a page number for the hydraulics chapter follows: chapter 13, section 20, page 3.

Example Page Number



Warnings, Cautions, and Notes

The following levels of written advisories are used throughout the manual.

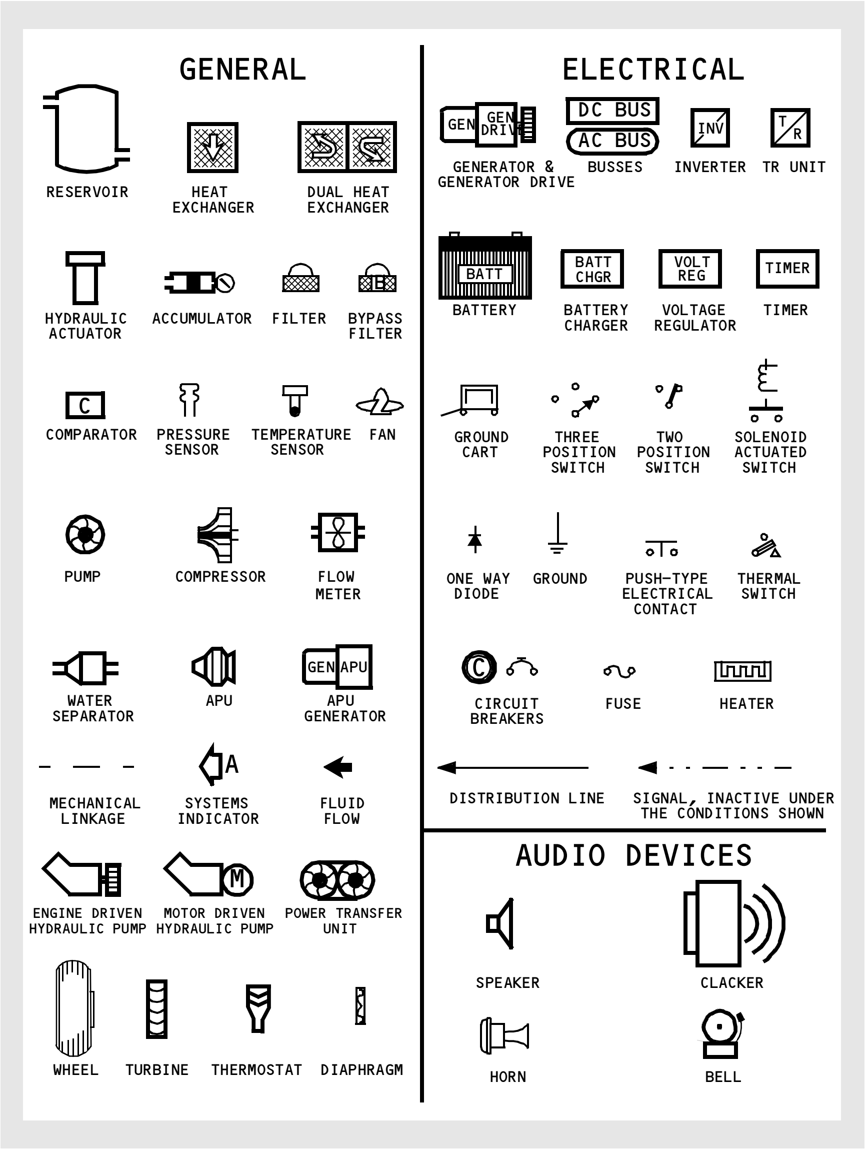
WARNING: An operating procedure, technique, etc., that may result in personal injury or loss of life if not carefully followed.

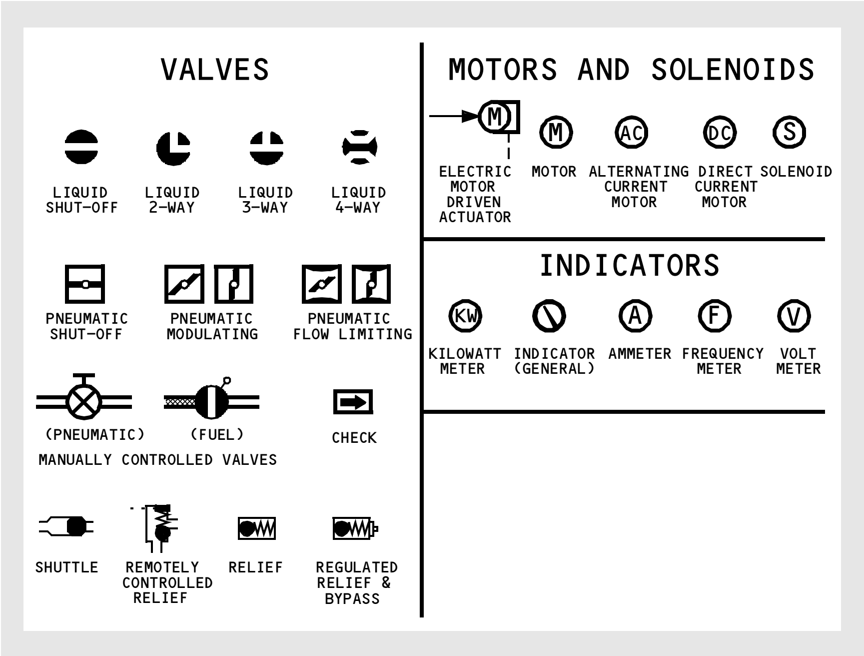
CAUTION: An operating procedure, technique, etc., that may result in damage to equipment if not carefully followed.

Note: An operating procedure, technique, etc., considered essential to emphasize. Information contained in notes may also be safety related.

Schematic Symbols

Symbols shown are those which may not be identified on schematic illustrations.




VALVES
LIQUID SHUT-OFF
LIQUID 2-WAY
LIQUID 3-WAY
LIQUID 4-WAY
PNEUMATIC SHUT-OFF
PNEUMATIC MODULATING
PNEUMATIC FLOW LIMITING
(PNEUMATIC)
(FUEL)
MANUALLY CONTROLLED VALVES
CHECK
SHUTTLE
REMOTELY CONTROLLED RELIEF
RELIEF
REGULATED RELIEF & BYPASS
MOTORS AND SOLENOIDS
M
ELECTRIC MOTOR DRIVEN ACTUATOR
M
MOTOR
AC
ALTERNATING CURRENT MOTOR
DC
DIRECT CURRENT MOTOR
S
SOLENOID
INDICATORS
KW
KILOWATT METER
INDICATOR (GENERAL)
A
AMMETER
F
FREQUENCY METER
V
VOLT METER

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General

The following abbreviations may be found throughout the manual. Some abbreviations may also appear in lowercase letters. Abbreviations having very limited use are explained in the chapter where they are used

A	
A/P	Autopilot
A/T	Autothrottle
AC	Alternating Current
ACARS	Aircraft Communications Addressing and Reporting System
ACP	Audio Control Panel
ACT	Active
ADF	Automatic Direction Finder
ADIRU	Air Data Inertial Reference Unit
ADM	Air Data Module
AED	Automatic External Defibrillator
AFDS	Autopilot Flight Director System
AFE	Above Field Elevation
AFM	Airplane Flight Manual (FAA approved)
AGL	Above Ground Level
AI	Anti–Ice
AIL	Aileron
ALT	Altitude
ALTN	Alternate

AM	Amplitude Modulation
ANP	Actual Navigation Performance
ANT	Antenna
AOA	Angle of Attack
APP	Approach
APU	Auxiliary Power Unit
ARINC	Aeronautical Radio, Incorporated
ARPT	Airport
ARTE	Above Runway Threshold Elevation
ATA	Actual Time of Arrival
ATC	Air Traffic Control
ATT	Attitude
AUTO	Automatic
AUX	Auxiliary
AVAIL	Available
B	
B/C or BCRS	Back Course
BARO	Barometric
BAT/BATT	Battery
BRT	Bright
BTL DISCH	Bottle Discharge (fire extinguishers)

BTP	Bromotrifluropropene (fire extinguishers)
C	
C	Captain Celsius Center
CANC/ RCL	Cancel/Recall
CB	Circuit Breaker
CDU	Control Display Unit
CG	Center of Gravity
CHKL	Checklist
CLB	Climb
COMM	Communication
CON	Continuous
CONFIG	Configuration
CRZ	Cruise
CTL	Control
D	
DC	Direct Current
DDG	Dispatch Deviations Guide
DEP ARR	Departure Arrival
DES	Descent
DISC	Disconnect
DME	Distance Measuring Equipment
DPC	Display Processing Computer
DSPL	Display
E	
E/D	End of Descent
E/E	Electrical and Electronic
EASA	European Aviation Safety Agency
EBAW	Enhanced Bank Angle Warning
ECS	Environmental Control System
EEC	Electronic Engine Control
EFIS	Electronic Flight Instrument System
EGPWS	Enhanced Ground Proximity Warning System
EGT	Exhaust Gas Temperature
ELEC	Electrical
ELEV	Elevator
ENG	Engine
EXEC	Execute
EXT	Extend
F	
F	Fahrenheit
F/D or FLT DIR	Flight Director
F/O	First Officer
FAF	Final Approach Fix. May be used in place of FAP
FAP	Final Approach Point
FCTL	Flight Control
FCTM	Flight Crew Training Manual
FFM	Force Fight Monitor
FL	Flight Level

FMC	Flight Management Computer
FMS	Flight Management System
FPA	Flight Path Angle
FPV	Flight Path Vector
FSEU	Flap Slat Electronic Unit
G	
G/S	Glide Slope
GA	Go–Around
GBAS	Ground-Based Augmentation System
GEN	Generator
GLS	GPS Landing System or GNSS Landing System or GBAS Landing System
GNSS	Global Navigation Satellite System
GP	Glide Path
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
H	
HDG	Heading
HDG REF	Heading Reference
HDG SEL	Heading Select
HPA	Hectopascals
HUD	Head-Up Display
HYD	Hydraulic
I	
IAS	Indicated Airspeed
IASC	Integrated Air Supply Controller
IDENT	Identification
ILS	Instrument Landing System
IN	Inches
INBD	Inboard Inbound
IND LTS	Indicator Lights
INOP	Inoperative
INTC CRS	Intercept Course
ISFD	Integrated Standby Flight Display
ISLN	Isolation
K	
K	Knots
KGS	Kilograms
L	
L	Left
LAM	Landing Attitude Modifier
LAT	Latitude
LBS	Pounds
LDG ALT	Landing Altitude
LE	Leading Edge
LIM	Limit
LNAV	Lateral Navigation
LOM	Locator Outer Marker
LONG	Longitude
LVL CHG	Level Change
M	
MAG	Magnetic

MAN	Manual
MCAS	Maneuver Characteristics Augmentation System
MCP	Mode Control Panel
MDA	Minimum Descent Altitude
MDS	MAX Display System
MEL	Minimum Equipment List
MFD	Multi-Function Display
MIN	Minimum
MKR	Marker
MLA	Maneuver Load Alleviation
MMO	Maximum Mach Operating Speed
MOD	Modify
MTRS	Meters
N	
N1	Low Pressure Rotor Speed
N2	High Pressure Rotor Speed
NAV RAD	Navigation Radio
ND	Navigation Display
NGS	Nitrogen Generation System
NM	Nautical Miles
NORM	Normal
O	
OHU	Overhead Unit
OVHD	Overhead
OVRD	Override

P	
PASS	Passenger
PCU	Power Control Unit
PERF INIT	Performance Initialization
PF	Pilot Flying
PFC	Primary Flight Computers
PM	Pilot Monitoring
PNL	Panel
POS	Position
POS INIT	Position Initialization
PRI	Primary
PRW	Perspective Runway
PTU	Power Transfer Unit
PWS	Predictive Windshear System
R	
R	Right
RA	Radio Altitude Resolution Advisory
RAAS	Runway Awareness and Advisory System
RECIRC	Recirculation
REF	Reference
RET	Retract
RF	Refill
RH	Right Hand
RNP	Required Navigation Performance
RVSM	Reduced Vertical Separation Minimum
S	

S/C	Step Climb
SEL	Select
SMYD	Stall Management Yaw Damper
SPD	Speed
SPLR	Spoiler
STA	Station
STAB	Stabilizer
STAT	Status
STD	Standard
STS	Speed Trim System
T	
T/D	Top of Descent
T or TK or TRK	Track
T or TRU	True
TA	Traffic Advisory
TAI	Thermal Anti-Ice
TAT	Total Air Temperature
TCAS	Traffic Alert and Collision Avoidance System
TDZE	Touch Down Zone Elevation
TE	Trailing Edge
TFC	Traffic
THR HLD	Throttle Hold
TO	Takeoff
TO/GA	Takeoff/Go–Around
U	
UTC	Universal Time Coordinated
V	
V/S	Vertical Speed
V1	Takeoff Decision Speed
V2	Takeoff Safety Speed
VA	Design Maneuvering Speed
VHF	Very High Frequency
VMO	Maximum Operating Speed
VNAV	Vertical Navigation
VOR	VHF Omnidirectional Range
VOX	Voice Operated Transmission
VR	Rotation Speed
VREF	Reference Speed
VSD	Vertical Situation Display
VTK	Vertical Track
W	
WPT	Waypoint
WXR	Weather Radar
X	
XTK	Cross Track

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Revision Transmittal Letter

To: All holders of Gol Linhas Aereas S.A. 737 Flight Crew Operations Manual (FCOM), Boeing Document Number MN-FLT-OH-201.

Subject: Flight Crew Operations Manual Revision.

This revision reflects the most current information available to The Boeing Company 60 days before the subject revision date. The following revision highlights explain changes in this revision. General information below explains the use of revision bars to identify new or revised information.

Revision Record

No.	Revision Date	Date Filed	No.	Revision Date	Date Filed
0	March, 2021				

General

The Gol 737 FCOM revisions are issued to provide new or revised procedures and information. Formal revisions also incorporate appropriate information from previously issued Fleet Bulletins.

The revision date is the approximate date the manual is approved for printing. The revision is mailed a few weeks after this date. This manual is effective upon receipt and supersedes any manual (with the same document number) with a previous revision number.

Formal revisions include a Transmittal Letter, a new Revision Record, Revision Highlights, and a current List of Effective Pages. Use the information on the new Revision Record and List of Effective Pages to verify the FCOM content.

Pages containing revised technical material have revision bars associated with the changed text or illustration. Editorial revisions (for example, spelling corrections) may have revision bars with no associated highlight.

The Revision Record should be completed by the person incorporating the revision into the manual.

Filing Instructions

Consult the List of Effective Pages (0.5). Pages identified with an asterisk (*) are either replacement pages or new (original) issue pages. Remove corresponding old pages and replace or add new pages. Remove pages that are marked DELETED; there are no replacement pages for deleted pages.

Be careful when inserting changes not to throw away pages from the manual that are not replaced. Using the List of Effective Pages (0.5) can help determine the correct content of the manual.

Revision Highlights

This section (0.4) replaces the existing section 0.4 in your manual.

Chapter 0 - Preface

Section 1 - Model Identification

General

0.1.1 - Added MAX8 EB1 description

Chapter SP - Supplementary Procedures

Section 15 - Warning Systems

Ground Proximity Warning System (GPWS), Overrun Warning (ORW) System, and Runway Awareness and Advisory System (RAAS) Test

SP.15.1 - Temporary Revision - Added Supplementary Procedures regarding RAAS system

Overrun Warning (ORW) System and Runway Awareness and Advisory System (RAAS) Inhibit Operation

SP.15.2 - Temporary Revision - Added Supplementary Procedures regarding RAAS system

Performance Package 10
737-8 LEAP-1B27 KG C M FAA CATB TO1-10% TO2-20%

Section 10 - Pkg Model Identification

New Performance Inflight Package 10

Section 10 - General

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

VREF

PI.10.6 - Updated table to expand maximum weight coverage.

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

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New Performance Inflight Package 10

Flight With Unreliable Airspeed/ Turbulent Air Penetration

PI.10.57 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.58 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.59 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.60 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.61 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.62 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.63 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.64 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.65 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.66 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.67 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.68 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.69 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.70 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.71 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.72 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.73 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Data revised for Maneuver Speeds to be based on airplane altitude instead of airport altitude. Added configurations for Flaps 5, Flaps 10, and Flaps 25 with Gear Up.

PI.10.74 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.74 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.75 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.75 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.76 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.76 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.77 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.77 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.78 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.78 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.79 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.79 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.80 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.80 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.81 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.81 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.82 - Reformatted all tables for improved readability. Included 1000 ft increments of airport altitude from -2000 ft to 14000 ft. Updated table due to calculation change that are now based on KIAS instead of KEAS.

PI.10.82 - Data revised to reflect expanded altitude coverage.

Section 11 - All Engine

New Performance Inflight Package 10

Section 11 - All Engine

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

Section 11 - All Engine

New Performance Inflight Package 10

New Performance Inflight Package 10

Section 12 - Advisory Information

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

Section 13 - Engine Inoperative

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

Section 14 - Alternate Mode EEC

New Performance Inflight Package 10

Section 14 - Alternate Mode EEC

New Performance Inflight Package 10

Section 14 - Alternate Mode EEC

New Performance Inflight Package 10

Section 14 - Alternate Mode EEC

New Performance Inflight Package 10

Section 15 - Alternate Mode EEC, Engine Inoperative

New Performance Inflight Package 10

Section 15 - Alternate Mode EEC

New Performance Inflight Package 10

Section 16 - GearDown

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

Section 17 - Gear Down, Engine Inop

New Performance Inflight Package 10

New Performance Inflight Package 10

New Performance Inflight Package 10

Long Range Cruise Control

PI.17.3 - Publishing system update, no data change.

New Performance Inflight Package 10

New Performance Inflight Package 10

Section 18 - Text

New Performance Inflight Package 10

General

PI.18.5 - Publishing system update, no data change.

Chapter 1 - Airplane General, Emergency Equipment, Doors, Windows

Section 20 - Instrument Panels

File Highlight

1.20.5 - Added graphic regarding MAX EB1 panel difference

Chapter 5 - Communications

Section 10 - Controls and Indicators

ACARS Printer

5.10.8 - Added ACARS Printer variation to reflect fleet variant

5.10.9 - Added ACARS Printer variation to reflect fleet variant

Chapter 13 - Hydraulics

Section 20 - System Description

Introduction

13.20.2 - Added Hydraulic Power Distribution Schematic for One-Poistion Tail Skid variant

Chapter 15 - Warning Systems

Section 10 - Controls and Indicators

Altitude Alert

15.10.7 - Added "200 feet" parameter to reflect EB1 fleet variation

15.10.7 - Added "200 feet" parameter to reflect EB1 fleet variation

Section 20 - System Description

Tail Skid

15.20.35 - Added "(as installed)" text to reflect fleet variant option with only one tail-skid position

15.20.37 - Added "(as installed)" text to reflect fleet variant option with only one tail-skid position

Volume 1

* = Revised, Added, or Deleted

* = Revised, Added, or Deleted

NP.21.54	March 1, 2021
NP.21.55	March 1, 2021
NP.21.56	March 1, 2021
NP.21.57	March 1, 2021
NP.21.58	March 1, 2021
NP.21.59	March 1, 2021
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NP.21.100	March 1, 2021
NP.21.101	March 1, 2021
NP.21.102	March 1, 2021

Supplementary Procedures

SP.TOC.1-8	October 26, 2021
SP.05.1	March 1, 2021
SP.05.2	March 1, 2021
SP.1.1	March 1, 2021
SP.1.2	March 1, 2021
SP.1.3	March 1, 2021
SP.1.4	March 1, 2021
SP.1.5	March 1, 2021
SP.1.6	March 1, 2021
SP.2.1	March 1, 2021
SP.2.2	March 1, 2021
SP.2.3	March 1, 2021
SP.2.4	March 1, 2021
SP.2.5	March 1, 2021
SP.2.6	March 1, 2021
SP.2.7	March 1, 2021
SP.2.8	March 1, 2021
SP.3.1	March 1, 2021
SP.3.2	March 1, 2021
SP.3.3	March 1, 2021
SP.3.4	March 1, 2021
SP.4.1	March 1, 2021
SP.4.2	March 1, 2021
SP.4.3	March 1, 2021
SP.4.4	March 1, 2021
SP.4.5	March 1, 2021
SP.4.6	March 1, 2021
SP.4.7	March 1, 2021
SP.4.8	March 1, 2021
SP.4.9	March 1, 2021
SP.4.10	March 1, 2021
SP.4.11	March 1, 2021
SP.4.12	March 1, 2021
SP.5.1	March 1, 2021
SP.5.2	March 1, 2021
SP.6.1	March 1, 2021
SP.6.2	March 1, 2021
SP.6.3	March 1, 2021
SP.6.4	March 1, 2021
SP.6.5	March 1, 2021
SP.6.6	March 1, 2021
SP.7.1	March 1, 2021
SP.7.2	March 1, 2021

* = Revised, Added, or Deleted

Performance Inflight

737-8 LEAP-1B27 KG C M FAA CATB TO1-10% TO2-20%

* = Revised, Added, or Deleted

PI.10.10	October 26, 2021	PI.10.57	October 26, 2021
PI.10.11	October 26, 2021	PI.10.58	October 26, 2021
PI.10.12	October 26, 2021	PI.10.59	October 26, 2021
PI.10.13	October 26, 2021	PI.10.60	October 26, 2021
PI.10.14	October 26, 2021	PI.10.61	October 26, 2021
PI.10.15	October 26, 2021	PI.10.62	October 26, 2021
PI.10.16	October 26, 2021	PI.10.63	October 26, 2021
PI.10.17	October 26, 2021	PI.10.64	October 26, 2021
PI.10.18	October 26, 2021	PI.10.65	October 26, 2021
PI.10.19	October 26, 2021	PI.10.66	October 26, 2021
PI.10.20	October 26, 2021	PI.10.67	October 26, 2021
PI.10.21	October 26, 2021	PI.10.68	October 26, 2021
PI.10.22	October 26, 2021	PI.10.69	October 26, 2021
PI.10.23	October 26, 2021	PI.10.70	October 26, 2021
PI.10.24	October 26, 2021	PI.10.71	October 26, 2021
PI.10.25	October 26, 2021	PI.10.72	October 26, 2021
PI.10.26	October 26, 2021	PI.10.73	October 26, 2021
PI.10.27	October 26, 2021	PI.10.74	October 26, 2021
PI.10.28	October 26, 2021	PI.10.75	October 26, 2021
PI.10.29	October 26, 2021	PI.10.76	October 26, 2021
PI.10.30	October 26, 2021	PI.10.77	October 26, 2021
PI.10.31	October 26, 2021	PI.10.78	October 26, 2021
PI.10.32	October 26, 2021	PI.10.79	October 26, 2021
PI.10.33	October 26, 2021	PI.10.80	October 26, 2021
PI.10.34	October 26, 2021	PI.10.81	October 26, 2021
PI.10.35	October 26, 2021	PI.10.82	October 26, 2021
PI.10.36	October 26, 2021	PI.11.1	October 26, 2021
PI.10.37	October 26, 2021	PI.11.2	October 26, 2021
PI.10.38	October 26, 2021	PI.11.3	October 26, 2021
PI.10.39	October 26, 2021	PI.11.4	October 26, 2021
PI.10.40	October 26, 2021	PI.11.5	October 26, 2021
PI.10.41	October 26, 2021	PI.11.6	October 26, 2021
PI.10.42	October 26, 2021	PI.11.7	October 26, 2021
PI.10.43	October 26, 2021	PI.11.8	October 26, 2021
PI.10.44	October 26, 2021	PI.11.9	October 26, 2021
PI.10.45	October 26, 2021	PI.11.10	October 26, 2021
PI.10.46	October 26, 2021	PI.12.1	October 26, 2021
PI.10.47	October 26, 2021	PI.12.2	October 26, 2021
PI.10.48	October 26, 2021	PI.12.3	October 26, 2021
PI.10.49	October 26, 2021	PI.12.4	October 26, 2021
PI.10.50	October 26, 2021	PI.12.5	October 26, 2021
PI.10.51	October 26, 2021	PI.12.6	October 26, 2021
PI.10.52	October 26, 2021	PI.12.7	October 26, 2021
PI.10.53	October 26, 2021	PI.12.8	October 26, 2021
PI.10.54	October 26, 2021	PI.12.9	October 26, 2021
PI.10.55	October 26, 2021	PI.12.10	October 26, 2021
PI.10.56	October 26, 2021	PI.12.11	October 26, 2021

* = Revised, Added, or Deleted

PI.12.12	October 26, 2021
PI.12.13	October 26, 2021
PI.12.14	October 26, 2021
PI.12.15	October 26, 2021
PI.12.16	October 26, 2021
PI.12.17	October 26, 2021
PI.12.18	October 26, 2021
PI.12.19	October 26, 2021
PI.12.20	October 26, 2021
PI.12.21	October 26, 2021
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PI.12.23	October 26, 2021
PI.12.24	October 26, 2021
PI.12.25	October 26, 2021
PI.12.26	October 26, 2021
PI.12.27	October 26, 2021
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PI.12.30	October 26, 2021
PI.12.31	October 26, 2021
PI.12.32	October 26, 2021
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PI.12.34	October 26, 2021
PI.12.35	October 26, 2021
PI.12.36	October 26, 2021
PI.12.37	October 26, 2021
PI.12.38	October 26, 2021
PI.12.39	October 26, 2021
PI.12.40	October 26, 2021
PI.12.41	October 26, 2021
PI.12.42	October 26, 2021
PI.13.1	October 26, 2021
PI.13.2	October 26, 2021
PI.13.3	October 26, 2021
PI.13.4	October 26, 2021
PI.13.5	October 26, 2021
PI.13.6	October 26, 2021
PI.13.7	October 26, 2021
PI.13.8	October 26, 2021
PI.13.9	October 26, 2021
PI.13.10	October 26, 2021
PI.13.11	October 26, 2021
PI.13.12	October 26, 2021
PI.13.13	October 26, 2021
PI.13.14	October 26, 2021
PI.14.1	October 26, 2021
PI.14.2	October 26, 2021
PI.14.3	October 26, 2021
PI.14.4	October 26, 2021
PI.15.1	October 26, 2021
PI.15.2	October 26, 2021
PI.15.3	October 26, 2021
PI.15.4	October 26, 2021
PI.15.5	October 26, 2021
PI.15.6	October 26, 2021
PI.15.7	October 26, 2021
PI.15.8	October 26, 2021
PI.16.1	October 26, 2021
PI.16.2	October 26, 2021
PI.16.3	October 26, 2021
PI.16.4	October 26, 2021
PI.16.5	October 26, 2021
PI.16.6	October 26, 2021
PI.17.1	October 26, 2021
PI.17.2	October 26, 2021
PI.17.3	October 26, 2021
PI.17.4	October 26, 2021
PI.17.5	October 26, 2021
PI.17.6	October 26, 2021
PI.18.1	October 26, 2021
PI.18.2	October 26, 2021
PI.18.3	October 26, 2021
PI.18.4	October 26, 2021
PI.18.5	October 26, 2021
PI.18.6	October 26, 2021
PI.18.7	October 26, 2021
PI.18.8	October 26, 2021
PI.18.9	October 26, 2021
PI.18.10	October 26, 2021
PI.18.11	October 26, 2021
PI.18.12	October 26, 2021
PI.18.13	October 26, 2021
PI.18.14	October 26, 2021
PI.18.15	October 26, 2021
PI.18.16	October 26, 2021

737-8 TS2 LEAP-1B28 KG C M FAA CATB TO1-10% TO2-20% ALT-AB (FMC Model 737-8.2) AOA-DIAL

PI.TOC.30.1-6	March 1, 2021
PI.ModID.30.1-2	October 26, 2021
PI.30.1	March 1, 2021
PI.30.2	March 1, 2021
PI.30.3	March 1, 2021
PI.30.4	March 1, 2021

* = Revised, Added, or Deleted

PI.30.5	March 1, 2021	PI.30.52	March 1, 2021
PI.30.6	March 1, 2021	PI.30.53	March 1, 2021
PI.30.7	March 1, 2021	PI.30.54	March 1, 2021
PI.30.8	March 1, 2021	PI.30.55	March 1, 2021
PI.30.9	March 1, 2021	PI.30.56	March 1, 2021
PI.30.10	March 1, 2021	PI.30.57	March 1, 2021
PI.30.11	March 1, 2021	PI.30.58	March 1, 2021
PI.30.12	March 1, 2021	PI.30.59	March 1, 2021
PI.30.13	March 1, 2021	PI.30.60	March 1, 2021
PI.30.14	March 1, 2021	PI.30.61	March 1, 2021
PI.30.15	March 1, 2021	PI.30.62	March 1, 2021
PI.30.16	March 1, 2021	PI.31.1	March 1, 2021
PI.30.17	March 1, 2021	PI.31.2	March 1, 2021
PI.30.18	March 1, 2021	PI.31.3	March 1, 2021
PI.30.19	March 1, 2021	PI.31.4	March 1, 2021
PI.30.20	March 1, 2021	PI.31.5	March 1, 2021
PI.30.21	March 1, 2021	PI.31.6	March 1, 2021
PI.30.22	March 1, 2021	PI.31.7	March 1, 2021
PI.30.23	March 1, 2021	PI.31.8	March 1, 2021
PI.30.24	March 1, 2021	PI.31.9	March 1, 2021
PI.30.25	March 1, 2021	PI.31.10	March 1, 2021
PI.30.26	March 1, 2021	PI.32.1	March 1, 2021
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PI.30.31	March 1, 2021	PI.32.6	March 1, 2021
PI.30.32	March 1, 2021	PI.32.7	March 1, 2021
PI.30.33	March 1, 2021	PI.32.8	March 1, 2021
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PI.30.35	March 1, 2021	PI.32.10	March 1, 2021
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PI.30.43	March 1, 2021	PI.32.18	March 1, 2021
PI.30.44	March 1, 2021	PI.32.19	March 1, 2021
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PI.30.46	March 1, 2021	PI.32.21	March 1, 2021
PI.30.47	March 1, 2021	PI.32.22	March 1, 2021
PI.30.48	March 1, 2021	PI.32.23	March 1, 2021
PI.30.49	March 1, 2021	PI.32.24	March 1, 2021
PI.30.50	March 1, 2021	PI.32.25	March 1, 2021
PI.30.51	March 1, 2021	PI.32.26	March 1, 2021

* = Revised, Added, or Deleted

Volume 2

1 Airplane General, Emergency Equipment, Doors, Windows

* = Revised, Added, or Deleted

1.20.16	March 1, 2021
1.30.1	March 1, 2021
1.30.2	March 1, 2021
1.30.3	March 1, 2021
1.30.4	March 1, 2021
1.30.5	March 1, 2021
1.30.6	March 1, 2021
1.30.7	March 1, 2021
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1.30.9	March 1, 2021
1.30.10	March 1, 2021
1.30.11	March 1, 2021
1.30.12	March 1, 2021
1.30.13	March 1, 2021
1.30.14	March 1, 2021
1.30.15	March 1, 2021
1.30.16	March 1, 2021
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1.30.18	March 1, 2021
1.30.19	March 1, 2021
1.30.20	March 1, 2021
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1.40.7	March 1, 2021
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1.40.41	October 26, 2021
1.40.42	October 26, 2021
1.40.43	October 26, 2021
1.40.44	October 26, 2021
1.40.45	October 26, 2021
1.40.46	October 26, 2021
1.40.47	October 26, 2021
1.40.48	October 26, 2021

2 Air Systems

2.TOC.1-2	March 1, 2021
2.10.1	March 1, 2021
2.10.2	March 1, 2021
2.10.3	March 1, 2021
2.10.4	March 1, 2021
2.10.5	March 1, 2021
2.10.6	March 1, 2021
2.10.7	March 1, 2021
2.10.8	March 1, 2021
2.10.9	March 1, 2021
2.10.10	March 1, 2021
2.10.11	March 1, 2021
2.10.12	March 1, 2021
2.20.1	March 1, 2021
2.20.2	March 1, 2021
2.20.3	March 1, 2021
2.20.4	March 1, 2021
2.20.5	March 1, 2021
2.20.6	March 1, 2021
2.30.1	March 1, 2021
2.30.2	March 1, 2021
2.30.3	March 1, 2021
2.30.4	March 1, 2021

* = Revised, Added, or Deleted

3 Anti-Ice, Rain

4 Automatic Flight

5 Communications

* = Revised, Added, or Deleted

5.10.2	October 26, 2021
5.10.3	October 26, 2021
5.10.4	October 26, 2021
5.10.5	October 26, 2021
5.10.6	October 26, 2021
5.10.7	October 26, 2021
5.10.8	October 26, 2021
5.10.9	October 26, 2021
5.10.10	October 26, 2021
5.10.11	October 26, 2021
5.10.12	October 26, 2021
5.10.13	October 26, 2021
5.10.14	October 26, 2021
5.10.15	October 26, 2021
5.10.16	October 26, 2021
5.10.17	October 26, 2021
5.10.18	October 26, 2021
5.10.19	October 26, 2021
5.10.20	October 26, 2021
5.10.21	October 26, 2021
5.10.22	October 26, 2021
5.20.1	March 1, 2021
5.20.2	March 1, 2021
5.20.3	March 1, 2021
5.20.4	March 1, 2021
5.20.5	March 1, 2021
5.20.6	March 1, 2021
5.20.7	March 1, 2021
5.20.8	March 1, 2021
5.20.9	March 1, 2021
5.20.10	March 1, 2021

6 Electrical

6.TOC.1-2	March 1, 2021
6.10.1	March 1, 2021
6.10.2	March 1, 2021
6.10.3	March 1, 2021
6.10.4	March 1, 2021
6.10.5	March 1, 2021
6.10.6	March 1, 2021
6.10.7	March 1, 2021
6.10.8	March 1, 2021
6.10.9	March 1, 2021
6.10.10	March 1, 2021
6.20.1	March 1, 2021
6.20.2	March 1, 2021
6.20.3	March 1, 2021
6.20.4	March 1, 2021
6.20.5	March 1, 2021
6.20.6	March 1, 2021
6.20.7	March 1, 2021
6.20.8	March 1, 2021
6.20.9	March 1, 2021
6.20.10	March 1, 2021
6.20.11	March 1, 2021
6.20.12	March 1, 2021
6.20.13	March 1, 2021
6.20.14	March 1, 2021
6.20.15	March 1, 2021
6.20.16	March 1, 2021
6.20.17	March 1, 2021
6.20.18	March 1, 2021

7 Engines, APU

7.TOC.1-2	March 1, 2021
7.10.1	March 1, 2021
7.10.2	March 1, 2021
7.10.3	March 1, 2021
7.10.4	March 1, 2021
7.10.5	March 1, 2021
7.10.6	March 1, 2021
7.10.7	March 1, 2021
7.10.8	March 1, 2021
7.10.9	March 1, 2021
7.10.10	March 1, 2021
7.10.11	March 1, 2021
7.10.12	March 1, 2021
7.10.13	March 1, 2021
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7.10.17	March 1, 2021
7.10.18	March 1, 2021
7.10.19	March 1, 2021
7.10.20	March 1, 2021
7.10.21	March 1, 2021
7.10.22	March 1, 2021
7.10.23	March 1, 2021
7.10.24	March 1, 2021
7.20.1	March 1, 2021
7.20.2	March 1, 2021
7.20.3	March 1, 2021
7.20.4	March 1, 2021
7.20.5	March 1, 2021

* = Revised, Added, or Deleted

* = Revised, Added, or Deleted

10.10.11	March 1, 2021	10.10.58	March 1, 2021
10.10.12	March 1, 2021	10.10.59	March 1, 2021
10.10.13	March 1, 2021	10.10.60	March 1, 2021
10.10.14	March 1, 2021	10.10.61	March 1, 2021
10.10.15	March 1, 2021	10.10.62	March 1, 2021
10.10.16	March 1, 2021	10.10.63	March 1, 2021
10.10.17	March 1, 2021	10.10.64	March 1, 2021
10.10.18	March 1, 2021	10.10.65	March 1, 2021
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10.10.29	March 1, 2021	10.15.2	March 1, 2021
10.10.30	March 1, 2021	10.15.3	March 1, 2021
10.10.31	March 1, 2021	10.15.4	March 1, 2021
10.10.32	March 1, 2021	10.15.5	March 1, 2021
10.10.33	March 1, 2021	10.15.6	March 1, 2021
10.10.34	March 1, 2021	10.15.7	March 1, 2021
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10.10.39	March 1, 2021	10.15.12	March 1, 2021
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10.10.45	March 1, 2021	10.15.18	March 1, 2021
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10.10.51	March 1, 2021	10.15.24	March 1, 2021
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10.10.54	March 1, 2021	10.20.3	March 1, 2021
10.10.55	March 1, 2021	10.20.4	March 1, 2021
10.10.56	March 1, 2021	10.20.5	March 1, 2021
10.10.57	March 1, 2021	10.20.6	March 1, 2021

* = Revised, Added, or Deleted

11 Flight Management, Navigation

* = Revised, Added, or Deleted

11.30.2	March 1, 2021	11.32.5	March 1, 2021
11.30.3	March 1, 2021	11.32.6	March 1, 2021
11.30.4	March 1, 2021	11.32.7	March 1, 2021
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11.31.2	March 1, 2021	11.33.1	March 1, 2021
11.31.3	March 1, 2021	11.33.2	March 1, 2021
11.31.4	March 1, 2021	11.33.3	March 1, 2021
11.31.5	March 1, 2021	11.33.4	March 1, 2021
11.31.6	March 1, 2021	11.33.5	March 1, 2021
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11.31.9	March 1, 2021	11.33.8	March 1, 2021
11.31.10	March 1, 2021	11.33.9	March 1, 2021
11.31.11	March 1, 2021	11.33.10	March 1, 2021
11.31.12	March 1, 2021	11.33.11	March 1, 2021
11.31.13	March 1, 2021	11.33.12	March 1, 2021
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11.31.15	March 1, 2021	11.33.14	March 1, 2021
11.31.16	March 1, 2021	11.33.15	March 1, 2021
11.31.17	March 1, 2021	11.33.16	March 1, 2021
11.31.18	March 1, 2021	11.33.17	March 1, 2021
11.31.19	March 1, 2021	11.33.18	March 1, 2021
11.31.20	March 1, 2021	11.33.19	March 1, 2021
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11.31.22	March 1, 2021	11.33.21	March 1, 2021
11.31.23	March 1, 2021	11.33.22	March 1, 2021
11.31.24	March 1, 2021	11.33.23	March 1, 2021
11.31.25	March 1, 2021	11.33.24	March 1, 2021
11.31.26	March 1, 2021	11.33.25	March 1, 2021
11.31.27	March 1, 2021	11.33.26	March 1, 2021
11.31.28	March 1, 2021	11.33.27	March 1, 2021
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11.31.33	March 1, 2021	11.33.32	March 1, 2021
11.31.34	March 1, 2021	11.33.33	March 1, 2021
11.31.35	March 1, 2021	11.33.34	March 1, 2021
11.31.36	March 1, 2021	11.33.35	March 1, 2021
11.31.37	March 1, 2021	11.33.36	March 1, 2021
11.31.38	March 1, 2021	11.33.37	March 1, 2021
11.31.39	March 1, 2021	11.33.38	March 1, 2021
11.31.40	March 1, 2021	11.33.39	March 1, 2021
11.32.1	March 1, 2021	11.33.40	March 1, 2021
11.32.2	March 1, 2021	11.33.41	March 1, 2021
11.32.3	March 1, 2021	11.33.42	March 1, 2021
11.32.4	March 1, 2021	11.33.43	March 1, 2021

* = Revised, Added, or Deleted

11.33.44	March 1, 2021	11.34.25	March 1, 2021
11.33.45	March 1, 2021	11.34.26	March 1, 2021
11.33.46	March 1, 2021	11.34.27	March 1, 2021
11.33.47	March 1, 2021	11.34.28	March 1, 2021
11.33.48	March 1, 2021	11.34.29	March 1, 2021
11.33.49	March 1, 2021	11.34.30	March 1, 2021
11.33.50	March 1, 2021	11.34.31	March 1, 2021
11.33.51	March 1, 2021	11.34.32	March 1, 2021
11.33.52	March 1, 2021	11.34.33	March 1, 2021
11.33.53	March 1, 2021	11.34.34	March 1, 2021
11.33.54	March 1, 2021	11.34.35	March 1, 2021
11.33.55	March 1, 2021	11.34.36	March 1, 2021
11.33.56	March 1, 2021	11.34.37	March 1, 2021
11.33.57	March 1, 2021	11.34.38	March 1, 2021
11.33.58	March 1, 2021	11.34.39	March 1, 2021
11.33.59	March 1, 2021	11.34.40	March 1, 2021
11.33.60	March 1, 2021	11.34.41	March 1, 2021
11.33.61	March 1, 2021	11.34.42	March 1, 2021
11.33.62	March 1, 2021	11.34.43	March 1, 2021
11.33.63	March 1, 2021	11.34.44	March 1, 2021
11.33.64	March 1, 2021	11.34.45	March 1, 2021
11.33.65	March 1, 2021	11.34.46	March 1, 2021
11.33.66	March 1, 2021	11.34.47	March 1, 2021
11.34.1	March 1, 2021	11.34.48	March 1, 2021
11.34.2	March 1, 2021	11.34.49	March 1, 2021
11.34.3	March 1, 2021	11.34.50	March 1, 2021
11.34.4	March 1, 2021	11.34.51	March 1, 2021
11.34.5	March 1, 2021	11.34.52	March 1, 2021
11.34.6	March 1, 2021	11.34.53	March 1, 2021
11.34.7	March 1, 2021	11.34.54	March 1, 2021
11.34.8	March 1, 2021	11.34.55	March 1, 2021
11.34.9	March 1, 2021	11.34.56	March 1, 2021
11.34.10	March 1, 2021	11.34.57	March 1, 2021
11.34.11	March 1, 2021	11.34.58	March 1, 2021
11.34.12	March 1, 2021	11.34.59	March 1, 2021
11.34.13	March 1, 2021	11.34.60	March 1, 2021
11.34.14	March 1, 2021	11.34.61	March 1, 2021
11.34.15	March 1, 2021	11.34.62	March 1, 2021
11.34.16	March 1, 2021	11.34.63	March 1, 2021
11.34.17	March 1, 2021	11.34.64	March 1, 2021
11.34.18	March 1, 2021	11.34.65	March 1, 2021
11.34.19	March 1, 2021	11.34.66	March 1, 2021
11.34.20	March 1, 2021	11.34.67	March 1, 2021
11.34.21	March 1, 2021	11.34.68	March 1, 2021
11.34.22	March 1, 2021	11.34.69	March 1, 2021
11.34.23	March 1, 2021	11.34.70	March 1, 2021
11.34.24	March 1, 2021	11.34.71	March 1, 2021

* = Revised, Added, or Deleted

11.34.72	March 1, 2021	11.41.1	March 1, 2021
11.40.1	March 1, 2021	11.41.2	March 1, 2021
11.40.2	March 1, 2021	11.41.3	March 1, 2021
11.40.3	March 1, 2021	11.41.4	March 1, 2021
11.40.4	March 1, 2021	11.41.5	March 1, 2021
11.40.5	March 1, 2021	11.41.6	March 1, 2021
11.40.6	March 1, 2021	11.41.7	March 1, 2021
11.40.7	March 1, 2021	11.41.8	March 1, 2021
11.40.8	March 1, 2021	11.41.9	March 1, 2021
11.40.9	March 1, 2021	11.41.10	March 1, 2021
11.40.10	March 1, 2021	11.41.11	March 1, 2021
11.40.11	March 1, 2021	11.41.12	March 1, 2021
11.40.12	March 1, 2021	11.41.13	March 1, 2021
11.40.13	March 1, 2021	11.41.14	March 1, 2021
11.40.14	March 1, 2021	11.41.15	March 1, 2021
11.40.15	March 1, 2021	11.41.16	March 1, 2021
11.40.16	March 1, 2021	11.41.17	March 1, 2021
11.40.17	March 1, 2021	11.41.18	March 1, 2021
11.40.18	March 1, 2021	11.41.19	March 1, 2021
11.40.19	March 1, 2021	11.41.20	March 1, 2021
11.40.20	March 1, 2021	11.41.21	March 1, 2021
11.40.21	March 1, 2021	11.41.22	March 1, 2021
11.40.22	March 1, 2021	11.41.23	March 1, 2021
11.40.23	March 1, 2021	11.41.24	March 1, 2021
11.40.24	March 1, 2021	11.41.25	March 1, 2021
11.40.25	March 1, 2021	11.41.26	March 1, 2021
11.40.26	March 1, 2021	11.41.27	March 1, 2021
11.40.27	March 1, 2021	11.41.28	March 1, 2021
11.40.28	March 1, 2021	11.41.29	March 1, 2021
11.40.29	March 1, 2021	11.41.30	March 1, 2021
11.40.30	March 1, 2021	11.41.31	March 1, 2021
11.40.31	March 1, 2021	11.41.32	March 1, 2021
11.40.32	March 1, 2021	11.41.33	March 1, 2021
11.40.33	March 1, 2021	11.41.34	March 1, 2021
11.40.34	March 1, 2021	11.42.1	March 1, 2021
11.40.35	March 1, 2021	11.42.2	March 1, 2021
11.40.36	March 1, 2021	11.42.3	March 1, 2021
11.40.37	March 1, 2021	11.42.4	March 1, 2021
11.40.38	March 1, 2021	11.42.5	March 1, 2021
11.40.39	March 1, 2021	11.42.6	March 1, 2021
11.40.40	March 1, 2021	11.42.7	March 1, 2021
11.40.41	March 1, 2021	11.42.8	March 1, 2021
11.40.42	March 1, 2021	11.42.9	March 1, 2021
11.40.43	March 1, 2021	11.42.10	March 1, 2021
11.40.44	March 1, 2021	11.42.11	March 1, 2021
11.40.45	March 1, 2021	11.42.12	March 1, 2021
11.40.46	March 1, 2021	11.42.13	March 1, 2021

* = Revised, Added, or Deleted

11.42.14	March 1, 2021	11.43.19	March 1, 2021
11.42.15	March 1, 2021	11.43.20	March 1, 2021
11.42.16	March 1, 2021	11.43.21	March 1, 2021
11.42.17	March 1, 2021	11.43.22	March 1, 2021
11.42.18	March 1, 2021	11.43.23	March 1, 2021
11.42.19	March 1, 2021	11.43.24	March 1, 2021
11.42.20	March 1, 2021	11.43.25	March 1, 2021
11.42.21	March 1, 2021	11.43.26	March 1, 2021
11.42.22	March 1, 2021	11.43.27	March 1, 2021
11.42.23	March 1, 2021	11.43.28	March 1, 2021
11.42.24	March 1, 2021	11.43.29	March 1, 2021
11.42.25	March 1, 2021	11.43.30	March 1, 2021
11.42.26	March 1, 2021	11.43.31	March 1, 2021
11.42.27	March 1, 2021	11.43.32	March 1, 2021
11.42.28	March 1, 2021	11.60.1	March 1, 2021
11.42.29	March 1, 2021	11.60.2	March 1, 2021
11.42.30	March 1, 2021	11.60.3	March 1, 2021
11.42.31	March 1, 2021	11.60.4	March 1, 2021
11.42.32	March 1, 2021	11.60.5	March 1, 2021
11.42.33	March 1, 2021	11.60.6	March 1, 2021
11.42.34	March 1, 2021	11.60.7	March 1, 2021
11.42.35	March 1, 2021	11.60.8	March 1, 2021
11.42.36	March 1, 2021	11.60.9	March 1, 2021
11.42.37	March 1, 2021	11.60.10	March 1, 2021
11.42.38	March 1, 2021	11.60.11	March 1, 2021
11.42.39	March 1, 2021	11.60.12	March 1, 2021
11.42.40	March 1, 2021	11.60.13	March 1, 2021
11.42.41	March 1, 2021	11.60.14	March 1, 2021
11.42.42	March 1, 2021	11.60.15	March 1, 2021
11.43.1	March 1, 2021	11.60.16	March 1, 2021
11.43.2	March 1, 2021	11.60.17	March 1, 2021
11.43.3	March 1, 2021	11.60.18	March 1, 2021
11.43.4	March 1, 2021	11.60.19	March 1, 2021
11.43.5	March 1, 2021	11.60.20	March 1, 2021
11.43.6	March 1, 2021	11.60.21	March 1, 2021
11.43.7	March 1, 2021	11.60.22	March 1, 2021
11.43.8	March 1, 2021	11.60.23	March 1, 2021
11.43.9	March 1, 2021	11.60.24	March 1, 2021
11.43.10	March 1, 2021	11.60.25	March 1, 2021
11.43.11	March 1, 2021	11.60.26	March 1, 2021
11.43.12	March 1, 2021	11.60.27	March 1, 2021
11.43.13	March 1, 2021	11.60.28	March 1, 2021
11.43.14	March 1, 2021	11.60.29	March 1, 2021
11.43.15	March 1, 2021	11.60.30	March 1, 2021
11.43.16	March 1, 2021	11.60.31	March 1, 2021
11.43.17	March 1, 2021	11.60.32	March 1, 2021
11.43.18	March 1, 2021	11.60.33	March 1, 2021

* = Revised, Added, or Deleted

11.60.34	March 1, 2021
11.60.35	March 1, 2021
11.60.36	March 1, 2021
11.60.37	March 1, 2021
11.60.38	March 1, 2021

12 Fuel

12.TOC.1-2	March 1, 2021
12.10.1	March 1, 2021
12.10.2	March 1, 2021
12.10.3	March 1, 2021
12.10.4	March 1, 2021
12.10.5	March 1, 2021
12.10.6	March 1, 2021
12.10.7	March 1, 2021
12.10.8	March 1, 2021
12.10.9	March 1, 2021
12.10.10	March 1, 2021
12.10.11	March 1, 2021
12.10.12	March 1, 2021
12.20.1	March 1, 2021
12.20.2	March 1, 2021
12.20.3	March 1, 2021
12.20.4	March 1, 2021
12.20.5	March 1, 2021
12.20.6	March 1, 2021

13 Hydraulics

13.TOC.1-2	October 26, 2021
13.10.1	March 1, 2021
13.10.2	March 1, 2021
13.10.3	March 1, 2021
13.10.4	March 1, 2021
13.10.5	March 1, 2021
13.10.6	March 1, 2021
13.20.1	March 1, 2021
13.20.2	October 26, 2021
13.20.3	October 26, 2021
13.20.4	October 26, 2021
13.20.5	October 26, 2021
13.20.6	October 26, 2021
13.20.7	October 26, 2021
13.20.8	October 26, 2021

14 Landing Gear

14.TOC.1-2	March 1, 2021
14.10.1	March 1, 2021
14.10.2	March 1, 2021
14.10.3	March 1, 2021
14.10.4	March 1, 2021
14.10.5	March 1, 2021
14.10.6	March 1, 2021
14.10.7	March 1, 2021
14.10.8	March 1, 2021
14.10.9	March 1, 2021
14.10.10	March 1, 2021
14.20.1	March 1, 2021
14.20.2	March 1, 2021
14.20.3	March 1, 2021
14.20.4	March 1, 2021
14.20.5	March 1, 2021
14.20.6	March 1, 2021
14.20.7	March 1, 2021
14.20.8	March 1, 2021
14.20.9	March 1, 2021
14.20.10	March 1, 2021

15 Warning Systems

15.TOC.1-2	March 1, 2021
15.10.1	March 1, 2021
15.10.2	October 26, 2021
15.10.3	October 26, 2021
15.10.4	October 26, 2021
15.10.5	October 26, 2021
15.10.6	October 26, 2021
15.10.7	October 26, 2021
15.10.8	March 1, 2021
15.10.9	March 1, 2021
15.10.10	March 1, 2021
15.10.11	March 1, 2021
15.10.12	March 1, 2021
15.10.13	March 1, 2021
15.10.14	March 1, 2021
15.10.15	March 1, 2021
15.10.16	March 1, 2021
15.20.1	March 1, 2021
15.20.2	October 26, 2021
15.20.3	October 26, 2021
15.20.4	October 26, 2021
15.20.5	October 26, 2021
15.20.6	October 26, 2021
15.20.7	October 26, 2021
15.20.8	October 26, 2021
15.20.9	October 26, 2021
15.20.10	October 26, 2021

* = Revised, Added, or Deleted

15.20.11	October 26, 2021
15.20.12	October 26, 2021
15.20.13	October 26, 2021
15.20.14	October 26, 2021
15.20.15	October 26, 2021
15.20.16	October 26, 2021
15.20.17	October 26, 2021
15.20.18	October 26, 2021
15.20.19	October 26, 2021
15.20.20	October 26, 2021
15.20.21	October 26, 2021
15.20.22	October 26, 2021
15.20.23	October 26, 2021
15.20.24	October 26, 2021
15.20.25	October 26, 2021
15.20.26	October 26, 2021
15.20.27	October 26, 2021
15.20.28	October 26, 2021
15.20.29	October 26, 2021
15.20.30	October 26, 2021
15.20.31	October 26, 2021
15.20.32	October 26, 2021
15.20.33	October 26, 2021
15.20.34	October 26, 2021
15.20.35	October 26, 2021
15.20.36	October 26, 2021
15.20.37	October 26, 2021
15.20.38	March 1, 2021

* = Revised, Added, or Deleted

General

The Boeing Company issues Flight Crew Operations Manual Bulletins to provide important information to flight crews prior to the next formal revision of the Flight Crew Operations Manual. The transmitted information may be of interest to only specific Operators or may apply to all Operators of this model airplane. Each bulletin will vary.

Bulletins are dated and numbered sequentially for each operator. Each new bulletin is recorded in this record when received and filed as instructed. A bulletin may not apply to all airplane models. When appropriate, the next formal FCOM revision will include an updated bulletin record page to reflect current bulletin status.

Temporary information is normally incorporated into the manual at the next formal revision. When the condition remains temporary after a bulletin incorporation, the temporary paragraphs are identified by a heading referencing the originating bulletin. When the temporary condition no longer exists, the bulletin is cancelled and the original manual content is restored.

Bulletin status is defined as follows:

- In Effect (IE) – the bulletin contains pertinent information not otherwise covered in the Flight Crew Operations Manual. The bulletin remains active and should be retained in the manual
- Incorporated (INC) – the bulletin operating information has been incorporated into the Flight Crew Operations Manual. However, the bulletin remains active and should be retained in the manual
- Cancelled (CANC) – the bulletin is no longer active and should be removed from the Flight Crew Operations Manual. All bulletins previously cancelled are no longer listed in the Bulletin Record.

The person filing a new or revised bulletin should amend the Bulletin Record as instructed in the Administrative Information section of the bulletin. When a bulletin includes replacement pages for the Flight Crew Operations Manual or QRH, the included pages should be filed as instructed in the Flight Crew Operations Manual Information section of the bulletin.

Number	Subject	Date	Status
GOT-1	Cabin Pressurization Panel Blanking/Dimming Issues	March 1, 2021	IE
GOT-2	Incorrect FMC Constraint Altitude on a Standard Terminal Arrival Route (STAR) with a Common Waypoint, after Selection of another Approach	March 1, 2021	IE
GOT-3	VNAV INVALID-PERF Scratchpad Message	March 1, 2021	IE
GOT-4	Digital Flight Data Recorder (DFDR) Amber OFF Light Illumination	March 1, 2021	IE
GOT-5	Bleed System Oscillations	March 1, 2021	IE
GOT-6	Nuisance Illumination of the Wing Anti-Ice VALVE Lights	March 1, 2021	IE
GOT-7	Nuisance Illumination of the COWL VALVE Lights	March 1, 2021	IE
GOT-8	START VALVE OPEN Alert Blinking at Starter Cutout	March 1, 2021	IE
GOT-9	Engine Starts with Outside Air Temperature (OAT) at 40C / 104F or Greater	March 1, 2021	IE
GOT-10	737 MAX Integrated ADIRU (I-ADIRU) and Automatic Navigation Realign (ANR) Mode	March 1, 2021	IE
GOT-12	Predictive Windshear System Anomaly	March 1, 2021	IE
GOT-13	Uncommanded Nose Down Stabilizer Trim Due to Erroneous Angle of Attack (AOA) During Manual Flight Only	March 1, 2021	IE
GOT-14	Lateral Path Exceedance on Approach Procedures with a Course Reversal	March 1, 2021	IE
GOT-15	Electronic Engine Control (EEC) Pressure Sensors Freezing	March 1, 2021	IE

Number	Subject	Date	Status
GOT-16	Elevator Jam Landing Assist Switch	March 1, 2021	IE
GOT-18	Speed Trim System (STS) and Autopilot Flight Director System (AFDS) with new Flight Control Computer (FCC) P12.1.2 software	March 1, 2021	IE

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Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-1

IssueDate: March 15, 2018

Subject: Cabin Pressurization Panel Blanking/Dimming Issues

Reason: To inform the crew of failures of the Cabin Pressurization Panel where the indications flicker, become too dim to read, or completely blank.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

The Cabin Pressurization Panel includes three displays: the FLT ALT indicator, LAND ALT indicator, and the outflow Valve Position Indicator, all of which use LED lighting technology. The same Cabin Pressurization Panel is used on the 737NG and several operators have reported occurrences where the LED display indications either flicker, become too dim to read, or completely blank. Most of the blanking reports indicate a self-recovery of the panel after a short duration of time. The duration of the effects can vary but it is typically momentary.

The cause of these occurrences is still under investigation by the manufacturer of the Cabin Pressurization Panel but early testing points to possible Electromagnetic Interference (EMI).

The Cabin Pressurization Panel is supplied by United Technologies (UTAS) and is P/N 1019439-1-001, equivalent Boeing P/N is 10-62231-31.

Boeing is working with UTAS to determine the cause of the Cabin Pressurization Panel failures. Once the cause of the problem and the appropriate fix is confirmed it will be introduced at the factory for new airplanes. For airplanes already in service Boeing will communicate appropriate fix instructions.

Currently the line number effectivity is not known therefore this FCOM bulletin will be revised when the information becomes available. Also included in the revision will be confirmation of the cause of the Cabin Pressurization Panel failures and a time line for the fix. In the meantime all 737MAX airplanes will necessitate the use of the procedures outlined in this bulletin if the Cabin Pressurization Panel displays fail.

Operating Instructions

If the Cabin Pressurization Panel display indications flicker, become too dim to read, or completely blank, it is important to note that the pressurization system will function as initially set by the crew. Cabin Pressurization Panel changes do not need to be made if a failure occurs and crew action is not needed or recommended.

If a Cabin Pressurization Panel failure occurs the crew should follow operator specific procedures or policies for reporting the failure.

The following action should be taken:

On the ground:

Do not takeoff.

In flight:

The Cabin Pressurization Panel failure should be momentary. Allow the Cabin Pressurization Panel to self-recover.

If the Cabin Pressurization Panel self-recovers, continue normal operation.

If the Cabin Pressurization Panel does not self-recover, avoid flight plan amendments requiring a change to the FLT ALT or LAND ALT on the Cabin Pressurization Panel.

If a situation requires a change on the Cabin Pressurization Panel to FLT ALT and the display is not visible:

Do not attempt to change the FLT ALT.

If the FLT ALT needs to be changed to a lower altitude than the current setting due to a change in cruise altitude:

No crew action is required. Operate the airplane at the new lower cruise altitude.

If the FLT ALT needs to be changed to a higher altitude than the current setting due to a change in cruise altitude:

No crew action is required. Operate the airplane at the new higher cruise altitude.

Note: Flying above the selected FLT ALT will drive the cabin to the maximum differential pressure. When the maximum cabin differential pressure is reached, the automatic control system will prioritize limiting differential pressure and will stop controlling cabin rate. If the airplane climbs after the maximum differential pressure is reached, the cabin rate will equal the airplane rate.

If a situation requires a change on the Cabin Pressurization Panel to LAND ALT and the display is not visible:

Do not attempt to change the LAND ALT.

Manually control cabin altitude when below 10,000 feet MSL or 3,000 feet above airport elevation, whichever is higher.

Landing must be accomplished with the airplane unpressurized.

Follow guidance provided in the Supplementary Procedures chapter of the Flight Crew Operations Manual (FCOM). Refer to SP.2, Air Systems, Manual Mode Operation.

Note: Verify desired outflow valve movement with changes on the cabin altimeter/differential pressure indicator and the cabin rate of climb indicator.

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GOL

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-2 R1

IssueDate: August 15, 2019

Airplane Effectivity: 737-8/-9 Airplanes with FMC U13

Subject: Incorrect FMC Constraint Altitude on a Standard Terminal Arrival Route (STAR) with a Common Waypoint, after Selection of another Approach

Reason: To inform crews about the incorrect FMC Constraint Altitude, when selecting another approach that has a common waypoint with the original STAR in the active flight plan.

This FCOMB is revised to include the 737 MAX-9.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

For airplanes with FMC U13, when a selected approach is changed to another approach that has a common waypoint with the original STAR, the FMC will use the higher constraint altitude for the common waypoint.

Operating Instructions

When a selected approach is changed for another approach that has a common waypoint with the original STAR, verify the waypoint constraint altitude after changing the selected approach.

This anomaly will be corrected in FMC software update U14.

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GOL

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-3

IssueDate: March 15, 2018

Airplane Effectivity: B737-7/8/9 Airplanes with FMC Software U13

Subject: VNAV INVALID-PERF Scratchpad Message

Reason: To inform the Flight Crews of an anomaly in which the VNAV INVALID-PERF scratchpad message cannot be cleared unless an approach is selected in the active flight plan.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

During a Boeing flight test the following software exception error was discovered. When certain forecast wind data is entered into the DES FORECAST page and no approach is selected in the active flight plan, FMC predictions stop, VNAV disengages, the VNAV INVALID-PERF scratchpad message shows and the FMC Alert Lights illuminate. This software exception causes the Cost Index (CI) to be replaced with box prompts on the PERF INIT page. The corrective action for VNAV INVALID-PERF scratchpad message is reentering the CI using either the previous or a new value on the PERF INIT page. Following the CI reentry, activating the data modification by pushing the execute (EXEC) key will restart FMC predictions and allow the crew to reengage VNAV.

However, it was discovered that with certain winds entered on the DES FORECAST page, it may not be possible to reenter a CI value on the PERF INIT page until an approach is selected into the active flight plan.

Note: The exact wind data entries that will trigger this anomaly are not known at this time.

Operating Instructions

When wind data is entered into the DES FORECAST page with no approach selected in the active flight plan, and the VNAV INVALID-PERF scratchpad message is shown in flight, an approach should be entered into the active flight plan. This should be followed by reentering the original CI or a new CI on the PERF INIT page. Afterwards, activating the data modification by pushing the execute (EXEC) key will restart FMC predictions and allow the crew to reengage VNAV.

The inability to reenter a CI if the VNAV INVALID-PERF scratchpad message is shown, can be avoided if an approach is selected in the active flight plan prior to the FMC-calculated Top of Descent (TOD), or if winds are not entered on the DES FORECAST page.

GOL

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-4 R1

IssueDate: February 21, 2019

Subject: Digital Flight Data Recorder (DFDR) Amber OFF Light Illumination

Reason: To inform the flight crew of nuisance illumination of the DFDR amber OFF light after the first engine start.

This bulletin is being revised to update the affected airplanes and to provide Service Bulletin and Fleet Team Digest information.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Certification flights on the 737-8 revealed intermittent and momentary illumination of the DFDR amber OFF light after the first engine start. Illumination of the OFF light also simultaneously caused the two master caution lights and amber OVERHEAD light on the system annunciator panel to momentarily illuminate. This anomaly affects 737-7/-8/-9 models prior to line number 7258.

Teledyne Controls, manufacturer of the Digital Flight Data Acquisition Unit (DFDAU), has determined the root cause to be contained within the DFDAU and is providing the fix via a DFDAU software update. Refer to Fleet Team Digest (FTD) 737MAX-FTD-31-17001 for additional information.

Operating Instructions

In the event the two master caution lights momentarily illuminate after the first engine start, no crew action is required provided no system annunciators remain illuminated after the recall check in the Before Taxi Procedure.

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GOL

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-5

IssueDate: March 15, 2018

Subject: Bleed System Oscillations

Reason: To inform the crew of bleed system oscillations with Engine Anti-Ice ON and Wing Anti-Ice OFF.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

During flight test the 737-8 has exhibited bleed system pressure oscillations. These oscillations were observed with takeoff or climb thrust set with Engine or Wing Anti-Ice ON or OFF. The oscillations have also been observed at reduced thrust settings during cruise or descent with Engine Anti-Ice ON and Wing Anti-Ice OFF. During the bleed system oscillations the L and R needles on the Bleed Air DUCT PRESSURE Indicator, located on the forward overhead panel, can fluctuate approximately plus or minus 10 psi out of phase with one another. This condition does not have any adverse effects on aircraft systems.

The oscillations are caused by unanticipated interaction of both the engine bleed air valves and the electronically controlled Flow Control Valves (eFCV). Boeing is working on the fix to these oscillations and will communicate appropriate implementation instructions as soon as possible.

737-7/8/-9 models are affected by this bulletin.

Operating Instructions

If bleed system oscillations are observed as described above, no crew action is needed.

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GOL

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-6

IssueDate: April 4, 2018

Subject: Nuisance Illumination of the Wing Anti-Ice VALVE Lights

Reason: This bulletin informs flight crews how to prevent nuisance illumination of the wing anti-ice VALVE lights when using wing anti-ice with idle thrust settings.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

During 737-8 flight tests, illumination of the amber wing VALVE lights occurred during use of the wing anti-ice system under the following conditions:

- Engine idle thrust descent above FL230
- Selecting wing anti-ice ON with engine anti-ice already in use.

Under the above conditions the L VALVE or R VALVE light can illuminate for approximately 15 seconds even with sufficient air pressure to operate the wing anti-ice valve. Illumination of the L VALVE or R VALVE light for more than approximately 10 seconds illuminates the two master caution lights and the amber ANTI-ICE light on the system annunciator panel.

The cause for the illumination of the L VALVE or R VALVE light is that the pressure switch sensing a transient bleed air pressure drop downstream of the wing anti-ice valve. It is important to note that even though the L VALVE or R VALVE can illuminate for approximately 15 seconds, sufficient bleed air pressure is available to provide wing anti-ice protection.

This anomaly affects 737-7/-8/-9 airplanes prior to Line Number 7000. For these airplanes Boeing will communicate appropriate modification instructions as soon as they become available.

Operating Instructions

If above FL230:

If the L VALVE or R VALVE light(s) illuminate with the master caution and the amber ANTI-ICE light on the system annunciator panel, wait 20 seconds after illumination of the master caution.

If both the L VALVE and R VALVE lights extinguish, continue normal operations. No further crew action is needed. No maintenance logbook write up is needed.

If the L VALVE or R VALVE light(s) remain illuminated, do the WING ANTI-ICE L/R VALVE Non-Normal Checklist.

If FL230 and below:

If the L VALVE or R VALVE light(s) illuminate with the master caution and the amber ANTI-ICE light on the system annunciator panel, do the WING ANTI-ICE L/R VALVE Non Normal Checklist.

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-7

IssueDate: April 4, 2018

Subject: Nuisance Illumination of the COWL VALVE Lights

Reason: This bulletin informs flight crews of nuisance illumination of the engine anti-ice COWL VALVE lights when using engine anti-ice at altitudes below FL230.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

During 737-8 flight tests, nuisance illumination of the amber COWL VALVE light(s) occurred when engine anti-ice was used at altitudes below FL230.

Depending on bleed air demands, the high stage valve modulates open to maintain adequate bleed air pressure. If the engine anti-ice is selected ON as the high stage valve modulates, a transient low pressure can occur which can cause the COWL VALVE light(s) to illuminate along with the master caution lights and the amber ANTI-ICE light on the system annunciator panel.

The cause for the illumination of the COWL VALVE light(s) is that the pressure switch senses a transient bleed air pressure drop downstream of the cowl anti-ice valve. It is important to note that even though the COWL VALVE light(s) can illuminate for approximately 15 seconds, sufficient bleed air pressure is available to provide engine anti-ice protection.

This anomaly affects 737-7/-8/-9 airplanes prior to Line Number 7000. For these airplanes Boeing will communicate appropriate modification instructions as soon as they become available.

Operating Instructions

If above FL230:

If the COWL VALVE light(s) illuminate with the master caution and the amber ANTI-ICE light on the system annunciator panel, do the ENGINE COWL VALVE OR TAI INDICATION Non-Normal Checklist.

If FL230 and below:

If the COWL VALVE light(s) illuminate with the master caution and the amber ANTI-ICE light on the system annunciator panel, wait 20 seconds after illumination of the master caution.

If the COWL VALVE light(s) extinguish, continue normal operations. No further crew action is needed. No maintenance logbook write up is needed.

If the COWL VALVE light(s) remain illuminated, do the ENGINE COWL VALVE OR TAI INDICATION Non-Normal Checklist.

GOL

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-8

IssueDate: May 10, 2018

Subject: START VALVE OPEN Alert Blinking at Starter Cutout

Reason: This bulletin informs flight crews of nuisance blinking of the START VALVE OPEN alert after reaching starter cutout speed.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

At starter cutout speed, momentary blinking of the START VALVE OPEN alert has occurred on 737 MAX flight tests.

The START VALVE OPEN alert and the entire crew alert block begins to blink if the start valve is still open 5 seconds after being commanded to close. In some cases, the timing of the command signal plus the time to close the start valve is slightly over the 5 second threshold, causing the alert to blink momentarily.

After starter cutout speed is reached, if the START VALVE OPEN alert blinks momentarily then extinguishes, the blinking can be considered a nuisance. Continued blinking for up to 10 seconds followed by steady illumination of the START VALVE OPEN alert is indication of a start valve malfunction.

This anomaly affects 737-7/-8/-9 airplanes with MDS software Blockpoint (BP) 1 and prior. MDS software BP2, scheduled for release 3Q2020, changes the threshold of the alert from 5 seconds to 7 seconds eliminating the nuisance alerts. Boeing will communicate appropriate fix instructions as soon as they become available.

Operating Instructions

After starter cutout speed is reached:

If the START VALVE OPEN alert blinks momentarily then extinguishes, no flight crew or maintenance action is needed.

If the START VALVE OPEN alert continues to blink for up to 10 seconds then illuminates steady, do the START VALVE OPEN Non-Normal Checklist.

GOL

Flight Crew Operations Manual Bulletin for Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-9 R1

IssueDate: November 17, 2018

Subject: Engine Starts with Outside Air Temperature (OAT) at 40°C / 104°F or Greater

Reason: To provide flight crews alternate engine start procedures in an effort to avoid a potential EGT exceedance when OAT is 40°C / 104°F or greater.

This bulletin is being revised to remove the requirement to ensure the ELECTRIC HYDRAULIC PUMP switches are ON in order to start engines during pushback. This revision aligns bulletin guidance with existing normal procedures. Service Bulletin information is also being provided.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

During certification for the 737-8, analysis was conducted for engine ground starts on cold engines and in hot ambient conditions. A cold engine is an engine with indicated EGT of 74°C or less. Analysis showed that engine starts conducted on cold engines and when the OAT was 47°C / 117°F or greater, the EGT start limit could often be reached before a successful engine start is achieved. Exceeding the EGT would require an Aborted Engine Start. The likelihood of exceeding the EGT start limit during the start attempt is related to the fuel schedule used by the EEC when the engine core temperature is near the ambient temperature.

In addition, operators have reported several situations when aborted engine starts were needed in order to avoid exceeding the EGT start limit. These situations occurred when the OAT was 40°C / 104°F and greater, and were not dependent on a cold or warm engine. This situation is related to separation of the Environmental Barrier Coating (EBC) in the engine core. When the EBC separates, the clearance between the turbine and the engine core is increased and therefore turbine efficiency is reduced. This reduction in turbine efficiency increases the likelihood of exceeding EGT during engine starts.

EEC software 6.5 adjusts the logic for the engine Transient Bleed Valve (TBV) schedule to reduce peak EGT during engine starts in both of the above conditions. Installation of EEC software 6.5 is available via Service Bulletin 737-73-1019. Airplanes equipped with EEC software version 6.5 or newer do not need the procedures outlined in this bulletin.

Operating Instructions

In coordination with engine manufacturer CFM International, Boeing recommends the following engine start procedure to be used when the OAT is 40°C / 104°F or greater.

Do the Engine Start Procedure except after the air conditioning PACK switches are set to OFF, continue with:

ENGINE HYDRAULIC PUMP switches. .... OFF

Start sequence .... Announce

Call "START ____ ENGINE"

ENGINE START switch .... GRD

Verify that the N2 RPM increases.

After MOTORING indication blanks, N1 rotation is seen, and N2 is at maximum motoring and a minimum of 20% N2.

Note: Maximum motoring occurs when N2 acceleration is less than 1% in approximately 5 seconds.

CAUTION: Do not apply rotational force when moving the engine start lever.

Engine start lever .... IDLE detent

Continue with the Engine Start Procedure.

When the first engine is stable at idle, start the other engine using the same procedures outlined above.

After both engines are stable at idle:

ENGINE HYDRAULIC PUMP switches .... ON

Verify all hydraulic panel LOW PRESSURE lights are extinguished.

Do the Before Taxi Procedure.

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Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-10

IssueDate: August 20, 2018

Subject: 737 MAX Integrated ADIRU (I-ADIRU) and Automatic Navigation Realign (ANR) Mode

Reason: To provide information to the flight crew of the flight deck effects of the ANR mode.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

The 737 MAX is equipped with I-ADIRU part number HG2050BC04 and it was revealed during flight test that after landing when the I-ADIRU enters the post-flight Auto Navigation Realign (ANR) mode it can cause some unexpected flight deck effects.

The purpose of the ANR mode is to automatically perform an IRS realignment when the airplane is motionless to remove drift errors associated with position and ground speed.

The ANR mode is active when the following conditions are met:

- The airplane is on ground
- The IRS Mode Selectors are in NAV mode
- The airplane remains motionless for 7.5 to 15 minutes depending on the airplane latitude

737 MAX airplanes with I-ADIRU part number HG2050BC04 that have been connected to the Multi-Mode Receiver (MMR) are capable of automatically accepting GPS position for IRS initializations (i.e. full alignment, Fast Realignment, and post-flight ANR mode).

Note: Position entered by the flight crew has priority over automatically accepted GPS position data. Once initialized, whether automatically by GPS or manually by the flight crew, GPS position is no longer automatically accepted by the I-ADIRU until after a flight is completed.

The FMC receives latitude, longitude and ground speed inputs from the I-ADIRU and uses this data to calculate its own FMC ground speed, track and position which are then displayed on the Navigation and Primary Flight Displays (ND and PFD).

The I-ADIRU position can drift over time during flight. In order to remove drift errors, the post-flight ANR mode is automatically activated after completion of a flight when the conditions described above are met. During post-flight ANR mode, the I-ADIRU accepts present GPS position from the MMR to automatically update IRS position and remove drift errors accumulated during flight.

When the I-ADIRU drift errors accumulated during flight are removed by the post-flight ANR mode, the FMC calculation of ground speed, track, and position can be adversely affected. One or more of the following flight deck effects can be observed on the ND and PFD:

- Slew of the compass rose on the ND for the “Track Up” display option (Figure 1)
- Slew of the track line on the ND for the “Heading Up” display option (Figure 2)
- Slew of the track line on the PFD compass rose (Figure 3)
- Change in the current track (Figure 4)
- Change in lateral path deviations (Figure 5)
- Change in FMC position resulting in a map shift (Figure 5)
    - There is a perceived change in GPS position due to the map shift (Figure 6)
- Change in the FMC ANP and ground speed (Figure 7)

- Change in ADIRU position (Figure 8)
- SPEEDBRAKE Warning (aural and visual) can alert, if this option is installed (figure 9)

Note: These flight deck effects happen post-flight only and are not always present. It depends on how much IRS drift error has occurred during flight (i.e. the difference between IRS position and GPS position) and whether the airplane remains motionless long enough for post-flight ANR mode to complete before IRS mode selectors are set to OFF or a full alignment or Fast Realignment is done. If the difference is small (approximately 1 nm), the FMC position, track, and ground speed transient errors may not be noticeable.

The flight deck effects described above will last approximately 10 - 120 seconds, depending on the IRS position update magnitude, after which the ND and PFD will return to normal and the visual SPEEDBRAKE Warning (if installed) will extinguish. Heading on the PFD and ND is not affected.

It is important to note that the flight deck effects described in the above are only possible when the post-flight ANR mode is active after completion of a flight and valid GPS position is received, i.e., cannot occur during taxi out even if the airplane remains stationary for approximately 7.5 to 15 minutes. Also, if the airplane is moved (motion detected) prior to the ANR mode completing the realignment, the ANR mode is stopped, I-ADIRU position drift errors remain and none of the flight deck effects described above are presented to the flight crew. The ANR mode timer is restarted from the beginning when the airplane again remains stationary (motionless).

The following is more specific information on 737 MAX models affected by this bulletin:

- 737-7 – All
- 737-8
  - Line number 6854 and earlier if Service Bulletin 737-34-3141 is incorporated
  - All from line number 6855 and on
- 737-9 – All

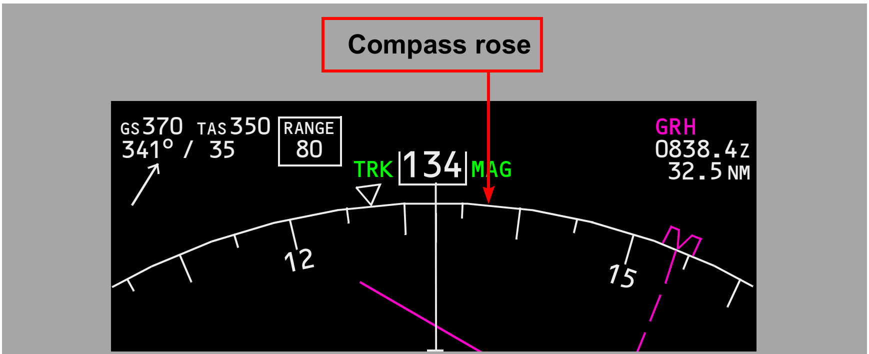

Figure 1

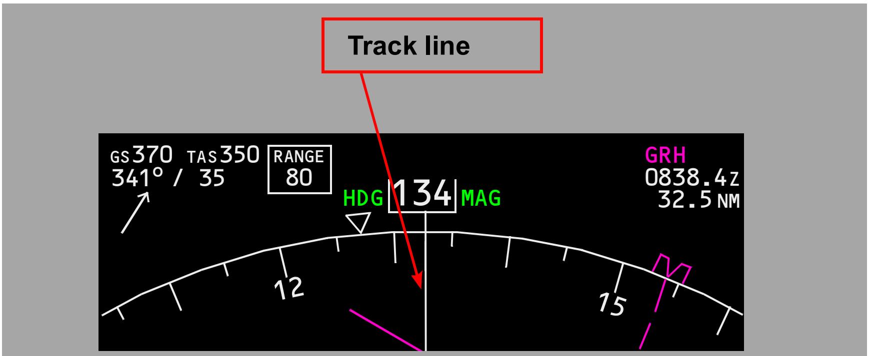

Figure 2

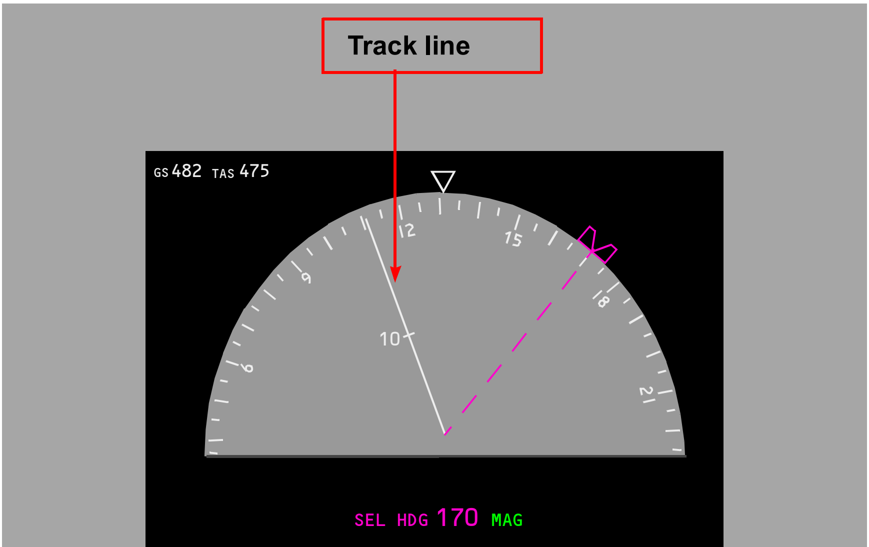

Figure 3

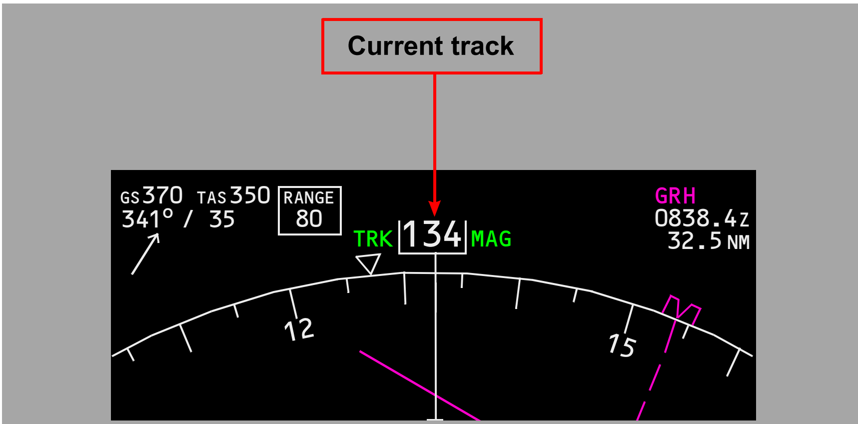

Figure 4

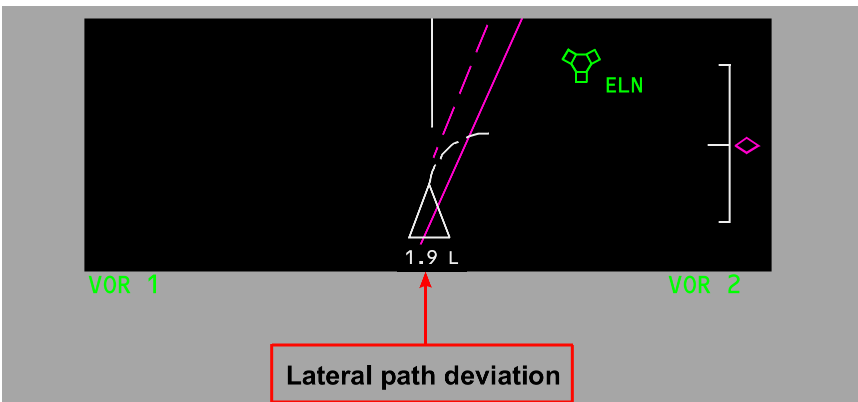

Figure 5

Figure 6

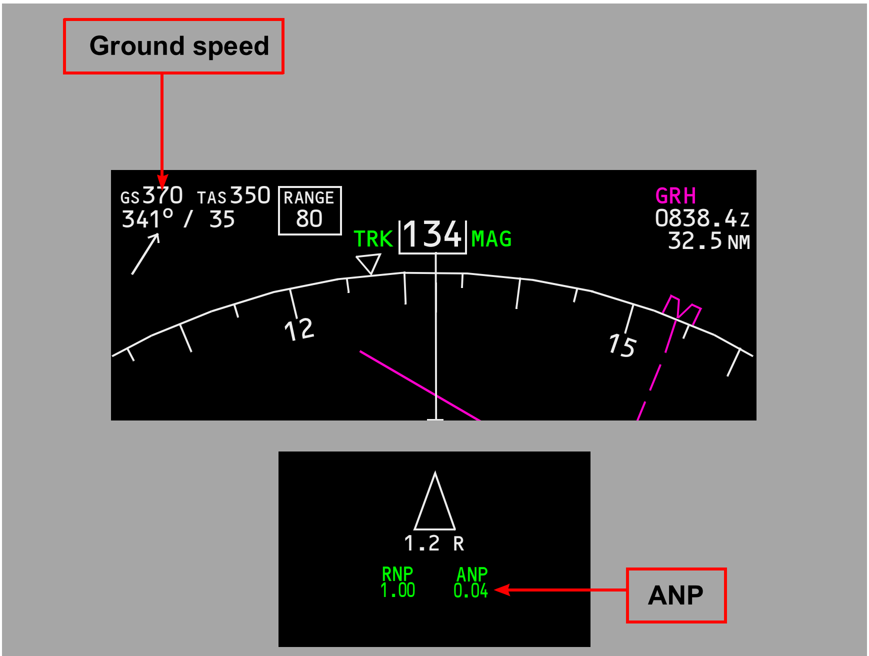

Figure 7

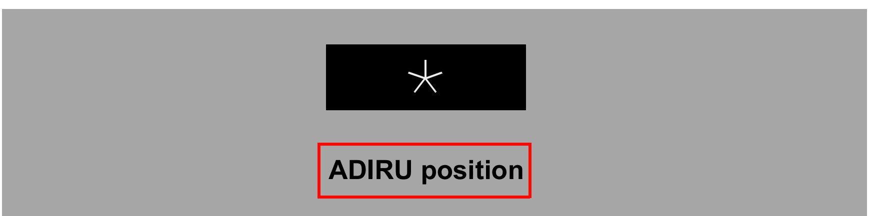

Figure 8

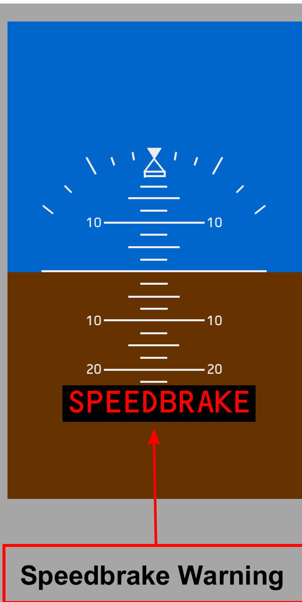

Figure 9

Operating Instructions

Before each flight complete a full IRS alignment and enter the most accurate latitude and longitude to initiate the alignment. If time does not allow a full alignment, do the Fast Realignment Supplementary Procedure.

If after completion of a flight the airplane remains stationary for approximately 7.5 - 15 minutes, the flight crew may observe one or more of the flight deck effects described in the background information. As the IRSs are operating per design no flight crew or maintenance action is needed.

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GOL

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-12

IssueDate: October 22, 2018

Subject: Predictive Windshear System Anomaly

Reason: This bulletin informs flight crews of the susceptibility of certain airports to false Predictive Windshear System (PWS) alerts.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Airlines have reported a false Predictive Windshear System (PWS) alert at the Rio de Janeiro airport (SBRJ). The anomaly is only applicable to PWS alerts; all reactive windshear alerts which occur are valid. These false alerts are limited to airplanes equipped with the Honeywell weather radar RDR-4000 with the following PWS weather radar processor part numbers:

- 930-1000-001
- 930-1000-002
- 930-1000-003

Honeywell has reviewed data provided by the affected airlines and has attempted to determine if particular airports and runways may be susceptible to “false alerts”. In addition, data have been analyzed to determine if the alerts are more likely during takeoff or on approach.

Honeywell has accumulated sufficient data to suggest that the following runway is susceptible to false PWS alerts:

- SBRJ (Rio de Janeiro), Runway 20L, Approach

Although this particular airport appears to be more susceptible to false alerts, the data indicates the majority of operations at this airport do not experience false PWS alerts.

Flight crews should use the following criteria to help determine if windshear exists:

- reports of windshear from other aircraft
- visual indications
- tower windshear alerts
- differences between computed winds in the airplane and reported winds from the tower.

As Honeywell continues to develop a software solution and to process data, operators are encouraged to continue reporting incidents to Honeywell and Boeing in order to provide the most effective solution possible to this anomaly.

Operating Instructions

If windshear is encountered, perform the Windshear Escape Maneuver.

It is recommended operators establish policies for flight crews operating into the reported runway in the event a PWS alert occurs. The following windshear criteria may be beneficial in establishing policies:

- reports of windshear from other aircraft
- visual indications
- tower windshear alerts
- differences between computed winds in the airplane and reported winds from the tower.

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-14

IssueDate: November 16, 2018

Airplane Effectivity: 737 MAX Airplanes with FMC Software U13

Subject: Lateral Path Exceedance on Approach Procedures with a Course Reversal

Reason: This bulletin informs flight crews of an FMC software U13 anomaly which generates an LNAV lateral path exceedance when flying an approach with a course reversal to the inbound leg.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Boeing and GE have received reports from operators of FMC generated LNAV lateral path exceedances when flying an approach with a course reversal to the inbound leg. Some of these approach procedures commence the course reversal at a specified DME and have a lateral limitation not to exceed XX.X DME. In certain instances, the FMC created path may result in exceeding the DME restriction.

This is an original anomaly in FMC U13 for the 737 MAX. This anomaly was introduced when a design change was made to prevent bypasses or discontinuities, based on procedure design of large track changes that are not flyable with high terminal ground speeds.

Operating Instructions

When executing approaches containing distance constrained course reversals on airplanes with FMC Software U13, crews should be aware of this anomaly and pay particular attention that the lateral path on the Navigation Display (ND) does not exceed the limits indicated on the approach procedure. This can be done by reviewing the procedure as displayed on the ND.

To mitigate this issue, it may be necessary to complete the course reversal using Heading Select (HDG SEL) to avoid a lateral path exceedance.

GOL

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-13

IssueDate: November 6, 2018

Airplane Effectivity: 737-8 / -9

Subject: Uncommanded Nose Down Stabilizer Trim Due to Erroneous Angle of Attack (AOA) During Manual Flight Only

Reason: To Emphasize the Procedures Provided in the Runaway Stabilizer Non-Normal Checklist (NNC).

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

The Indonesian National Transportation Safety Committee has indicated that Lion Air flight 610 experienced erroneous AOA data. Boeing would like to call attention to an AOA failure condition that can occur **during manual flight only.** This bulletin directs flight crews to existing procedures to address this condition.

In the event of erroneous AOA data, the pitch trim system can trim the stabilizer nose down in increments lasting up to 10 seconds. The nose down stabilizer trim movement can be stopped and reversed with the use of the electric stabilizer trim switches but may restart 5 seconds after the electric stabilizer trim switches are released. Repetitive cycles of uncommanded nose down stabilizer continue to occur unless the stabilizer trim system is deactivated through use of both STAB TRIM CUTOUT switches in accordance with the existing procedures in the Runaway Stabilizer NNC. It is possible for the stabilizer to reach the nose down limit unless the system inputs are counteracted completely by pilot trim inputs and both STAB TRIM CUTOUT switches are moved to CUTOUT.

Additionally, pilots are reminded that an erroneous AOA can cause some or all of the following indications and effects:

- Continuous or intermittent stick shaker on the affected side only.
- Minimum speed bar (red and black) on the affected side only.
- Increasing nose down control forces.
- Inability to engage autopilot.
- Automatic disengagement of autopilot.
- IAS DISAGREE alert.
- ALT DISAGREE alert.
- AOA DISAGREE alert (if the AOA indicator option is installed)
- FEEL DIFF PRESS light.

Operating Instructions

In the event an uncommanded nose down stabilizer trim is experienced on the 737-8 /-9, in conjunction with one or more of the above indications or effects, do the Runaway Stabilizer NNC ensuring that the STAB TRIM CUTOUT switches are set to CUTOUT and stay in the CUTOUT position for the remainder of the flight.

Note: Initially, higher control forces may be needed to overcome any stabilizer nose down trim already applied. Electric stabilizer trim can be used to neutralize control column pitch forces before moving the STAB TRIM CUTOUT switches to CUTOUT. Manual stabilizer trim can be used after the STAB TRIM CUTOUT switches are moved to CUTOUT.

GOL

Flight Crew Operations Manual Bulletin for Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-15

IssueDate: December 21, 2018

Airplane Effectivity: 737-7/-8/-9

Subject: Electronic Engine Control (EEC) Pressure Sensors Freezing

Reason: To inform flight crews that if the pressure sensing system contains moisture, freezing can occur which can cause N1 oscillations.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

An operator recently experienced N1 oscillations on an engine during a level off in descent. The root cause of the oscillations was found to be the freezing of moisture which had accumulated in the engine control pressure sensing system used to measure Compressor Discharge Pressure (PS3). The PS3 signal is used by the EEC for engine control scheduling. The freezing causes erroneous PS3 values which can cause abnormal engine behavior. Changes in the PS3 values being selected by the engine control system caused the N1 oscillations.

With the autothrottle engaged, the autothrottle attempted to recover the loss in N1 by increasing thrust. The autothrottle reaction to the thrust oscillations prolonged the event. During the N1 oscillations, the amber THRUST alert flashed without steady illumination. The range of the N1 oscillations observed were up to 12% N1. When the autothrottle was disengaged, the oscillations stopped after a few more oscillation cycles.

The ENGINE CONTROL or the MAINT light can illuminate 30 seconds after landing.

Boeing is working with CFM on hardware modifications to improve elimination of moisture in the PS3 sensing system and to prevent any freezing. Improvements in EEC software 6.7, expected for release 2Q 2019, will prevent the oscillations. This FCOM bulletin will be revised to include Service Bulletin information when it becomes available.

Operating Instructions

In the event that N1 oscillations as described above occur, the flight crew should do the Engine Limit or Surge or Stall non-normal checklist (NNC).

GOL

Flight Crew Operations Manual Bulletin for Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-16

IssueDate: March 27, 2019

Airplane Effectivity: 737-7 / -8 / -9

Subject: Elevator Jam Landing Assist Switch

Reason: To inform flight crews of the possibility that the Elevator Jam Landing Assist switch installed on some airplanes is a 3 position switch instead of the correct 2 position switch.

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

The Elevator Jam Landing Assist switch on the 737 MAX is supposed to be a guarded 2 position switch. The 2 positions are ON and OFF with the switch guard closed to the OFF position. During production testing on a 737-8 airplane, it was discovered that the Elevator Jam Landing Assist switch installed on some airplanes has a 3 position switch, an ON position, an OFF position and a middle position. The middle position is not wired and is therefore equivalent to the OFF position. Regardless of whether the correct 2 position switch or incorrect 3 position switch is installed, the panel is only labeled for a 2 position switch and labeled with ON and OFF. When the guard is closed, the switch can only be in the middle or OFF positions.

Boeing has worked with the switch manufacturer, Honeywell, to identify the issue. Service Letter 737-27-275 has been released to provide a switch replacement process.

Boeing has determined that airplanes from line number 7065 to line number 7278 might have the incorrect 3 position switch installed. However, airplanes outside of this line number range might also be affected since spare switches may have been sent directly from Honeywell to operators.

Operating Instructions

Normal Procedures

During the Preliminary Preflight Procedure – Captain or First Officer, ensure the guard is closed.

Non-Normal Procedures

In the event a non-normal checklist (NNC) directs the crew to use the Elevator Jam Landing Assist switch, ensure complete movement of the switch to either the ON or OFF position as directed by the NNC. The following NNCs have steps for the Elevator Jam Landing Assist switch:

- ASSIST ON
- Jammed or Restricted Flight Controls

GOL

Flight Crew Operations Manual Bulletin
for
Gol Linhas Aereas S.A.

Fleet Bulletin 737

Number: GOT-18

IssueDate: March 1, 2021

Airplane Effectivity: 737-7/-8/-8200/-9 with FCC P12.1.2 or newer

Subject: Speed Trim System (STS) and Autopilot Flight Director System (AFDS) with new Flight Control Computer (FCC) P12.1.2 software

Reason: To provide enhanced FCOM Description of the Speed Trim System, including MCAS, and the Autopilot Flight Director System. This bulletin outlines the revisions to seven Non-Normal Checklists (NNCs) in QRH Sections 9 and 10, QRH Checklist Instructions (CI), and system description content in Chapter 9 (Flight Controls) and Section 10 (Flight Instruments, Displays).

Information in this bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

On November 6, 2018, Boeing issued a bulletin to the 737-8/-9 fleet regarding uncommanded nose down stabilizer trim. That bulletin described how the Maneuvering Characteristics Augmentation System (MCAS) function of the Speed Trim System in the existing FCC software could trim the stabilizer nose down due to erroneous elevated Angle of Attack (AOA) input.

Background Information (continued)

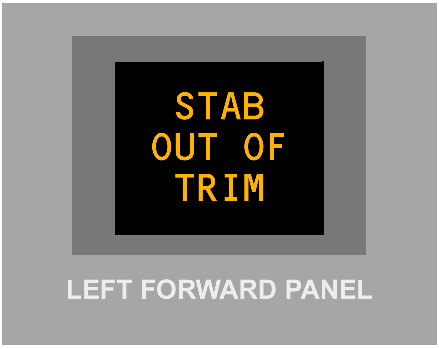
New FCC software, P12.1.2, is being introduced which includes enhancements to the Speed Trim System and more specifically the MCAS function. The new FCC software reduces opportunities for erroneous MCAS activation and reduces the maximum MCAS stabilizer trim authority. In addition, FCC software P12.1.2 introduces updates to the Autopilot Flight Director System. These updates include changes to autopilot nose up stabilizer trim (flaps extended only), automatic autopilot disengagement and flight director guidance when stick shaker activates (only for AFDS modes that do not have minimum speed reversion).

This bulletin is being issued to easily identify the updated information and is organized in the same format as the FCOM. All of these descriptions are also incorporated in this FCOM revision. The SPEED TRIM FAIL and STABILIZER OUT OF TRIM Non-Normal Checklists have been revised as a direct result of the introduction of FCC P12.1.2. In addition, five other Non-Normal Checklists have also been revised. All of these Non-Normal Checklists are also included in this FCOM revision and outlined in this bulletin for easy reference. In addition, the QRH-CI have been updated to provide flight crew guidance for management of non-normal situations.

All deliveries of 737-7/-8/-8200/-9 airplanes after the issue date of this bulletin will include the new FCC P12.1.2 software. For 737-8/-9 airplanes not delivered with FCC P12.1.2, Service Bulletin 737-22A1342 will be made available to provide FCC P12.1.2 software installation instructions.

Automatic Flight Chapter 4 - Controls and Indicators Section 10

Autopilot / Autothrottle Indicators



Stabilizer Out Of Trim (STAB OUT OF TRIM) Light

Illuminated (amber) –

- In-flight
  - Autopilot is not properly trimming the stabilizer.
  - Partial failure of a Flight Control Computer.
  - Illuminates only with autopilot engaged. Remains extinguished when the autopilot is not engaged.
- On the ground
  - Partial failure of a Flight Control Computer.
  - Illuminates after landing when groundspeed is less than 30 knots.

Automatic Flight Chapter 4 - System Description Section 20

Autopilot Disengagement

In addition to those conditions already listed in the FCOM, the autopilot automatically disengages for these additional conditions:

- one second after activation of stick shaker if autopilot is engaged in ALT HOLD, VNAV ALT (as installed), VNAV PTH (in a level segment), VNAV PTH (flaps 15 or greater), V/S (flaps 15 or greater), G/P (as installed) or G/S (single channel only) modes. Refer to Flight Director Display in this section for effects on flight director commands.
- five minutes after continuous activation of stick shaker if not in any of the above modes.
- five minutes after continuous stick shaker activation if the autopilot was re-engaged.

Flight Director Display

Turning a F/D switch ON displays command bars on the respective pilot's attitude indicator if command pitch and roll modes are engaged. If command pitch and roll modes are not engaged, the F/D command bars do not appear. The F/Ds can be operated with or without the A/P and A/T. F/D command modes can be used with an A/P engaged in CWS.

F/D commands operate in the same command modes as the A/P except:

- the takeoff mode is a F/D only mode
- dual F/D guidance is available for single engine operation
- the F/D has no landing flare capability. F/D command bars retract from view at approximately 50 feet RA on an ILS approach.

F/D commands are removed one second after activation of stick shaker for AFDS modes that do not have minimum speed reversion. The F/D command bars (both pitch and roll) return when airspeed increases to the top of the minimum maneuver speed (amber) bar. Refer to Minimum Speed Reversion in this section for additional information.

Normally, FCC A drives the captain's command bars and FCC B drives the first officer's command bars. With both F/D switches ON, the logic for both pilots' F/D modes is controlled by the master FCC, and both FMA displays show the same mode status.

The master FCC is indicated by illumination of the respective master (MA) F/D indicator light. The master FCC is determined as follows:

- with neither A/P engaged in CMD, the FCC for the first F/D turned on is the master
- with one or both A/Ps engaged in CMD, the FCC for the first A/P in CMD is the master FCC, regardless of which F/D is turned on first.

F/D modes are controlled directly from the respective FCC under certain conditions. This independent F/D operation occurs when neither A/P is engaged in CMD, both F/D switches are ON and one of the following mode conditions exists:

- APP mode engaged with LOC and G/S captured
- GA mode engaged and below 400 feet RA
- TO mode engaged and below 400 feet RA.

For non-approach modes, if the pilot is flying manually but not following the flight director guidance in the roll mode and then selects autopilot CMD engagement, the autopilot will engage into the current flight director roll mode.

Independent F/D operation is indicated by illumination of both MA lights. When independent operation terminates, the MA light extinguishes on the slaved side.

Flight Director Display (continued)

If a generator is lost during a F/D TO or GA, or while in dual F/D APP mode below 800 feet, the FCC on the unaffected side positions the F/D command bars on both attitude indicators. If the F/D MA light on the affected side had been illuminated, it extinguishes upon electrical bus transfer.

Minimum Speed Reversion

The AFDS and A/T do not control to a speed which is less than minimum speed for the current flap configuration. This speed is approximately 1.3 Vs. Minimum speed, FMC speed, or selected speed, whichever is higher, becomes the AFS commanded speed. If actual speed becomes equal to or slightly less than the minimum speed, the underspeed limiting symbol appears in the MCP IAS/MACH display, and if operating in the V/S mode or CWS P, the AFDS reverts to LVL CHG. The AFDS will also revert to LVL CHG from VNAV PTH, except when flying a level segment.

The AFS commands a speed 5 knots greater than minimum speed. Reaching a speed 5 knots greater than minimum speed reactivates normal MCP speed selection control. The AFDS commands nose down pitch to increase airspeed if the thrust levers are not advanced. When actual speed becomes 5 knots greater than minimum speed, the underspeed limiting symbol disappears.

The A/P disengages and the F/D command bars retract when in a LVL CHG climb with a command speed equal to minimum speed and a minimum rate of climb cannot be maintained without decelerating.

Minimum Speed Reversion (continued)

There is no minimum speed reversion from the following modes:

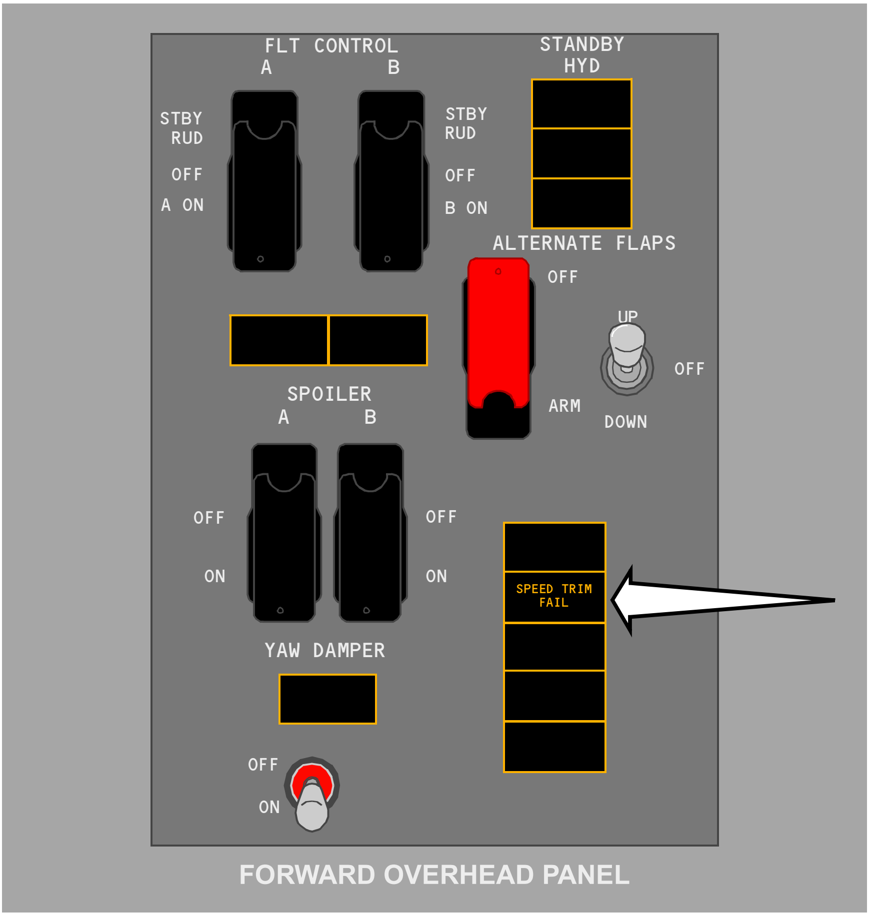
- ALT HOLD
- VNAV ALT (as installed)
- VNAV PTH (in a level segment)
- VNAV PTH (not in a level segment and flaps 15 or greater)
- V/S (flaps 15 or greater)
- G/P (as installed)
- G/S

In the above modes with the autopilot engaged, the autopilot disengages and the F/D command bars (both pitch and roll) are removed one second after stick shaker activation. When airspeed increases to the top of the minimum maneuver speed (amber) bar, the F/D command bars (both pitch and roll) return and the autopilot can be re-engaged. If the previous F/D pitch commands were ALT HOLD, VNAV ALT (as installed) or VNAV PTH (in a level segment), the F/D pitch commands return in MCP SPD mode. Both the Indicated Airspeed (IAS) display and the speed bug will reference the existing airspeed when the F/D command bars return into view. If the previous F/D pitch commands were V/S (flaps 15 or greater), VNAV PTH (flaps 15 or greater), G/S or G/P (as installed), the F/D pitch commands return in the previous V/S, VNAV PTH, G/S or G/P (as installed) mode, respectively. For all cases the roll command returns in the previous mode.

Note: It is possible that stick shaker does not occur simultaneously on both the Captain and First Officer side due to AOA vane angle tolerances. In the event that stick shaker does not occur simultaneously, F/D command bars are removed one second after stick shaker activates on that side.

Flight Controls Chapter 9 - Controls and Indicators Section 10

Flight Control Panel



Speed Trim Failure (SPEED TRIM FAIL) Light

Illuminated (amber) –

- indicates failure of the Speed Trim System (Speed Trim function or MCAS function). If one function fails, the other function is inhibited.
- indicates failure of a single FCC channel when MASTER CAUTION recall is activated and light extinguishes when Master Caution System is reset.

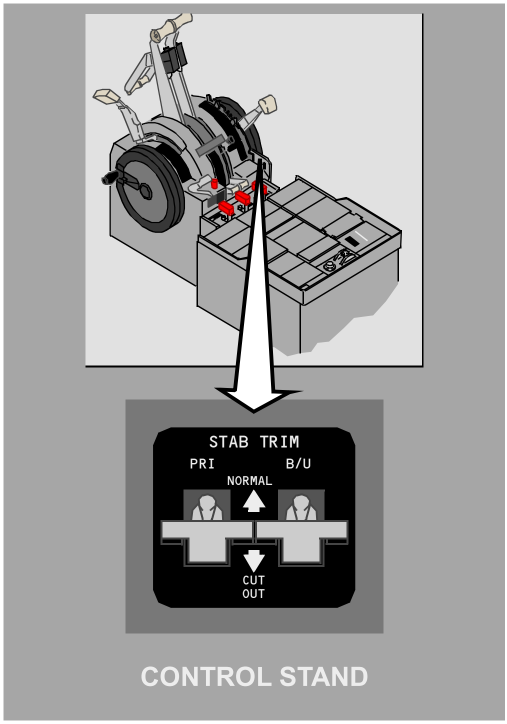
Stabilizer

Main Electric Stabilizer Trim Switches (spring-loaded to neutral)

Push (both) –

- electrically commands stabilizer trim in desired direction
- autopilot disengages if engaged
- overrides Speed Trim System (Speed Trim function and MCAS function) if active.

Stabilizer (continued)



Stabilizer Trim PRI (primary) Cutout switch

NORMAL – normal operating position.

CUTOUT – stops stabilizer trim inputs from main electric, autopilot and Speed Trim System (Speed Trim function and MCAS function).

Stabilizer Trim B/U (backup) Cutout switch

NORMAL – normal operating position.

CUTOUT – stops stabilizer trim inputs from main electric, autopilot and Speed Trim System (Speed Trim function and MCAS function).

Aileron / Elevator / Flight Spoilers

Control Column

Push -

- operates elevators in the nose down direction
- interrupts main electric, autopilot and Speed Trim System (Speed Trim function and MCAS function) nose up stabilizer trim commands.

Pull -

- operates elevators in the nose up direction
- interrupts main electric, autopilot and Speed Trim function nose down stabilizer trim commands
- does not interrupt MCAS nose down stabilizer trim commands.

Flight Controls Chapter 9 - System Description Section 20

Stabilizer Trim

Main electric stabilizer trim switches on each control wheel actuate the electric trim motor through the main electric stabilizer trim circuit when the airplane is flown manually. With the autopilot engaged, stabilizer trim is accomplished through the autopilot stabilizer trim circuit. The main electric and autopilot stabilizer trim have two speed modes: high speed with flaps extended and low speed with flaps retracted. In addition, with flaps extended, the autopilot trim stops stabilizer nose up trim commands when airspeed is three knots or more into the minimum maneuver speed (amber) bar. If the autopilot is engaged, actuating either pair of main electric stabilizer trim switches automatically disengages the autopilot. The stabilizer trim wheels rotate whenever main electric stabilizer trim is actuated.

The STAB TRIM PRI cutout switch and the STAB TRIM B/U cutout switch are located on the control stand. If either switch is positioned to CUTOUT, the autopilot, main electric and Speed Trim System (Speed Trim function and MCAS function) trim inputs are disconnected from the stabilizer trim motor.

Control column actuated stabilizer trim cutout switches interrupts operation of main electric stabilizer trim, autopilot trim and the Speed Trim function when the control column movement opposes trim direction. Aft control column movement does not interrupt Maneuvering Characteristics Augmentation System (MCAS) nose down trim commands. Forward control column movement interrupts MCAS nose up trim commands.

In addition to the control column actuated stabilizer trim cutout switches, the FCC contains a software column cutout function which adds a layer of redundancy to mitigate a latent failure of the column cutout switches. The control column cutout function interrupts operation of autopilot trim and the Speed Trim function when the control column movement opposes trim direction. Aft control column movement does not interrupt MCAS nose down trim commands. Forward control column movement interrupts MCAS nose up trim commands. The software column cutout function cuts out automatic stabilizer commands beyond the cutout position of the control column actuated stabilizer trim cutout switches. Main electric stabilizer trim commands are not inhibited.

When the STAB TRIM override switch is positioned to OVRD, main electric stabilizer trim can be used regardless of control column position.

Stabilizer Trim (continued)

Manual stabilizer control is accomplished through cables which allow the pilot to position the stabilizer by rotating the stabilizer trim wheels. The stabilizer is held in position by two independent brake systems. Manual rotation of the trim wheels can be used to set the desired stabilizer position, after the STAB TRIM cutout switches have been placed in the CUTOUT position. The effort required to manually rotate the stabilizer trim wheels may be higher under certain flight conditions such as at high airspeeds. Grasping the stabilizer trim wheel will stop stabilizer motion.

Speed Trim System

The Speed Trim System (STS) provides speed and pitch stability augmentation. Speed stability augmentation is provided by the Speed Trim function in the Speed Trim System. Pitch stability augmentation is provided by the MCAS function in the Speed Trim System. The Speed Trim System only operates while the autopilot is not engaged. If the SPEED TRIM FAIL light is illuminated, Speed Trim System (Speed Trim function and MCAS function) operation is inhibited. Main electric stabilizer trim switches can be used to override Speed Trim System inputs.

If the left and right AOAs disagree by 5.5 degrees or more with the flaps retracted, the SPEED TRIM FAIL light illuminates and the Speed Trim System (Speed Trim function and MCAS function) is inhibited for the remainder of the flight.

Note: The Speed Trim System (Speed Trim function and MCAS function) is inhibited with either the STAB TRIM PRI cutout switch or the STAB TRIM B/U cutout switch in the CUTOUT position.

Speed Trim Function

Speed Trim is a speed stability augmentation function designed to improve flight characteristics during operations with a low gross weight, aft center of gravity and high thrust when the autopilot is not engaged. The purpose is to return the airplane to a trimmed speed by commanding the stabilizer in a direction opposite the speed change. The Speed Trim function monitors inputs of stabilizer position, thrust lever position, flap position, airspeed and vertical speed to determine the amount of stabilizer trim and rate at which to control the stabilizer trim motor. As the airplane speed increases or decreases from the trimmed speed, the stabilizer is commanded in the direction needed to return the airplane to the trimmed speed. This increases control column forces to encourage return to the trimmed speed. As the airplane returns to the trimmed speed, the commanded stabilizer movement is removed.

The Speed Trim function contains a High AOA mode that is used to provide increased stabilizer commands at elevated AOA. As AOA increases toward stick shaker, the Speed Trim function transitions to the High AOA mode to command additional nose down stabilizer to increase control column forces. AOA is used only to transition into and out of the High AOA mode and does not determine the amount of stabilizer command.

The Speed Trim function controls the stabilizer trim motor at a high rate with flaps extended and low rate with flaps retracted.

Speed Trim Function (continued)

The Speed Trim function operates most frequently during takeoff, climb and go-around. Conditions for operation are listed below:

- Up to Mach 0.68
- 10 seconds after takeoff
- 5 seconds following release of main electric stabilizer trim switches
- Autopilot not engaged
- Sensing of trim requirement

Maneuvering Characteristics Augmentation System (MCAS) Function

MCAS is a pitch stability augmentation function designed to operate at elevated angles of attack (AOAs). The purpose is to increase control column forces by commanding the stabilizer in the nose down direction at elevated AOAs.

The MCAS function becomes active when the airplane exceeds a threshold AOA. Stabilizer trim inputs in the nose down direction are added incrementally if AOA continues to increase. Stabilizer trim commands are based on AOA and Mach number. As AOA is reduced below threshold AOA, the commanded stabilizer trim is removed. If AOA is again increased above threshold AOA, MCAS becomes active and again commands stabilizer trim inputs in the nose down direction. The MCAS function controls the stabilizer trim motor at the flaps extended Speed Trim function rate.

The FCC uses a corrected AOA value to activate MCAS. This logic uses both AOA vanes and filters out small differences between the vanes and provides a single corrected value to the MCAS function.

The MCAS function contains logic that limits the amount of nose down stabilizer trim movement to preserve elevator authority for pitch control. When MCAS activates, the command limit logic computes a nose down stabilizer trim limit. If stabilizer trim reaches the computed limit, the SPEED TRIM FAIL light illuminates and the Speed Trim System (Speed Trim function and MCAS function) is inhibited for the remainder of the flight. Manual stabilizer trim, main electric stabilizer trim and autopilot trim are not affected by the command limit logic. The command limit logic inhibits the Speed Trim System when the computed nose down stabilizer trim limit is reached:

- within five minutes following MCAS activation, or
- before the autopilot has been engaged for one continuous minute following MCAS activation.

The command limit logic is reset after five minutes or after the autopilot has been engaged for one minute, whichever occurs first.

Conditions for operation are listed below:

- AOA above threshold
- Up to Mach 0.84
- 10 seconds after takeoff
- Flaps up
- Autopilot not engaged

Stall Identification

Stall identification and control is enhanced by the yaw damper, the Elevator Feel Shift (EFS) module and the Speed Trim System. These three systems work together to help the pilot identify and prevent further movement into a stall condition.

During high AOA operations, the Stall Management/Yaw Damper (SMYD) reduces yaw damper commanded rudder movement.

The EFS module increases hydraulic system A pressure to the elevator feel and centering unit during a stall. This approximately doubles control column forces. The EFS module is armed whenever an inhibit condition is not present. Inhibit conditions are: on the ground, radio altitude less than 100 feet and autopilot engaged. However, if EFS is active when descending through 100 feet RA, it remains active until AOA is reduced below approximately stick shaker threshold. There are no flight deck indications that the system is properly armed or activated.

As airspeed decreases towards stall speed with flaps down, the Speed Trim System uses the Speed Trim function to trim the stabilizer nose down above stick shaker AOA. With flaps up, as AOA approaches stick shaker, the stabilizer nose down trim commands transition from the Speed Trim function to the MCAS function. These trim schedules produce a predictable and increasing column force with increasing aft column displacement. With the column aft, the amount of column force increase is more pronounced with the onset of EFS.

Flight Control Computer Monitors

The Flight Control Computers contain monitors which provide protection against possible runaway stabilizer conditions caused by erroneous FCC stabilizer trim commands. The FCCs continuously monitor each other's stabilizer trim commands, and in the event an erroneous command is detected, stabilizer trim commands, autopilot trim commands, and CWS trim commands are stopped and inhibited for the remainder of the flight for that FCC. These trim commands are then provided by the other FCC. In addition, main electric stabilizer trim remains available.

Autopilot Elevator Monitor

The Autopilot Elevator Monitor protects against erroneous elevator commands that can result in erroneous autopilot stabilizer trim commands. The Autopilot Elevator Monitor is available when:

- Autopilot is engaged, in single channel, and
- Pitch mode is other than G/S or G/P, and
- Flaps are 15 or less.

If the Autopilot Elevator Monitor activates:

- The STAB OUT OF TRIM light illuminates in flight and remains illuminated until the condition is no longer present or the autopilot is disengaged.
- The STAB OUT OF TRIM light illuminates after landing when groundspeed is less than 30 knots.

Note: The Speed Trim System remains available.

Stabilizer Cross-FCC Trim Monitor

The Cross-FCC Trim Monitor protects against erroneous stabilizer trim commands. The Cross-FCC Trim Monitor is available when a single autopilot is engaged and during manual flight.

If the Cross-FCC Trim Monitor activates:

- The autopilot or CWS can automatically disengage causing the associated aural and visual alerts.
- The SPEED TRIM FAIL light can illuminate automatically, during MASTER CAUTION recall, or not at all.
- The STAB OUT OF TRIM light illuminates after landing when groundspeed is less than 30 knots.

Non-Normal Checklists

This bulletin outlines the revisions to seven NNCs. An overview of the revisions to each NNC is included below.

Section 9, Flight Controls (NNC.9):

Runaway Stabilizer NNC

The Runaway Stabilizer NNC memory steps have been reformatted and the reference steps have been revised for standardization purposes. A memory step has been added to control airspeed.

SPEED TRIM FAIL NNC

The SPEED TRIM FAIL NNC condition statement has been revised to state that both the Speed Trim Function and the MCAS function are inoperative for the remainder of the flight. A note has also been added with regards to deviations from a trimmed airspeed.

STABILIZER OUT OF TRIM NNC

The functionality of the STAB OUT OF TRIM light has been revised. The light can illuminate in flight or on the ground to indicate a partial failure of the FCC.

Stabilizer Trim Inoperative NNC

The Stabilizer Trim Inoperative NNC has been revised for standardization purposes.

Non-Normal Checklists (continued)

Section 10, Flight Instruments, Displays (NNC.10):

Airspeed Unreliable NNC

The Airspeed Unreliable NNC has been revised as follows:

- Added a step to allow the flight crew to bypass the use of the Flight with Unreliable Airspeed table if the flight crew is able to determine a reliable airspeed source.
- Added explanation that the autopilot may not engage or disengages automatically, and that the airplane may no longer meet RVSM airspace requirements.
- Added deferred items section to provide guidance on the setting of BARO minimums and in the event of a go-around or missed approach.

ALT DISAGREE NNC

The ALT DISAGREE NNC has been revised to direct the flight crew to do the Airspeed Unreliable NNC if the IAS DISAGREE alert is also shown. Amended the deferred items section by adding guidance on the setting of BARO minimums.

AOA DISAGREE NNC

The AOA DISAGREE NNC has been revised to direct the flight crew to do the Airspeed Unreliable NNC.

QRH Checklist Instructions

The Non-Normal Checklist Operation description in the QRH CI has been updated to provide flight crew guidance for management of non-normal situations. Refer to QRH Chapter CI, Section 2.

Operating Instructions

This bulletin outlines the revisions to QRH Non-Normal Checklists in Section 9, Flight Controls (NNC.9) and Section 10, Flight Instruments, Displays (NNC.10). This bulletin also outlines the revisions to the QRH-CI and system description content.

The following NNCs are being revised:

Section 9, Flight Controls (NNC.9)

- Runaway Stabilizer NNC
- SPEED TRIM FAIL NNC
- STABILIZER OUT OF TRIM NNC
- Stabilizer Trim Inoperative NNC

Section 10, Flight Instruments, Displays (NNC.10)

- Airspeed Unreliable NNC
- ALT DISAGREE NNC
- AOA DISAGREE NNC

The revised NNCs and QRH-CI are included in the QRH. The revised system descriptions are included in FCOM Volume 2.

Limitations — Chapter L
Table of Contents — Section TOC

General

This chapter contains:

- Airplane Flight Manual (AFM) limitations
- Non-AFM operational information.

Limitations and operational information are included if they are:

- operationally significant
- required by FAA Airworthiness Directive
- required by another regulatory requirement.

Limitations and operational information are not included if they are:

- incorporated into FCOM normal, supplementary, or non-normal procedures, with a few exceptions
- shown on a placard, display, or other marking.

Limitations and operational information listed in this chapter that must be memorized (memory items) are marked with a (#) symbol. Memory items must meet the following criterion – flight crew access by reference cannot assure timely compliance; e.g., Maximum Takeoff and Landing Tailwind Component. Memory items need only be memorized to the extent that compliance is assured. Knowing the exact wording of the limitation is not required.

Assuming that the remaining items are available to the flight crew by reference, they do not need to be memorized.

In some cases Gol Linhas Aéreas S.A. policies may direct more restrictive limitations. For example, a specific 737 may be AFM approved for takeoffs and landings with tailwind up to 15 knots, but the airline policy directs a more restrictive limitation for up to 10 knots for standardization throughout the 737 fleet.

Airplane General

AFM Limitations

Runway slope	±2%
# Maximum Takeoff and Landing Tailwind Component	10 knots
Maximum Speeds	Observe gear and flap placards
Maximum Operating Altitude	41,000 feet pressure altitude
Maximum Takeoff and Landing Altitude	8,400 feet pressure altitude

Maximum flight operating latitude is dependent on the configuration of the Magnetic Variation tables in the ADIRU as follows: 82° North and 82° South, except for the region between 80° West and 170 ° West longitude, the maximum flight operating latitude is 73° North, and the region between 120° East and 160° East longitude, the maximum flight operating latitude is 60° South.

Installation of handle covers on the overwing exits must be verified prior to departure whenever passengers are carried.

Verify that an operational check of the flight deck door access system has been accomplished according to approved procedures once each flight day.

Ground Wind Operating Envelope

- For crosswinds greater than 43 knots, limit thrust to a setting normally used for taxi.
- Except when setting takeoff thrust on the runway, limit engine thrust to idle for winds greater than 58 knots.

AFM Operational Information

Severe Turbulent Air Penetration speed is 280 KIAS / .76M, whichever is lower. Applicable to Climb and Descent only. During Cruise, refer to SP.16, Severe Turbulence Supplementary Procedure.

Non-AFM Operational Information

On revenue flights, the escape slide retention bar (girt bar) must be installed during taxi, takeoff and landing.

Do not operate HF radios during refueling operations.

Altitude Display Limits For RVSM Operations

Standby altimeters do not meet altimeter accuracy requirements of RVSM airspace.

The maximum allowable in-flight difference between Captain and First Officer altitude displays for RVSM operations is 200 feet.

The maximum allowable on-the-ground altitude display differences for RVSM operations are:

Field Elevation	Max Difference Between Captain & F/O	Max Difference Between Captain or F/O & Field Elevation
Sea Level to 5,000 feet	50 feet	75 feet
5,001 to 10,000 feet	60 feet	75 feet

Weight Limitations

AFM Limitations

Note: The maximum weight limitations can be further limited as referenced in the WEIGHT LIMITATIONS section of the CERTIFICATE LIMITATIONS chapter of the AFM.

Note: Possible conflicts between the AFM and the FCOM may occur due to separate publication release dates. In the event of a conflict between the FCOM and the AFM, the AFM shall govern.

	737 MAX 8
Maximum Taxi Weight	82,417 Kilograms
Maximum Takeoff Weight	82,190 Kilograms
Maximum Landing Weight	69,308 Kilograms
Maximum Zero Fuel Weight	64,818Kilograms

Air Systems

AFM Limitations

Pressurization

The maximum cabin differential pressure (relief valves) is 9.1 psi.

Non-AFM Operational Information

With either one or both engine bleed air switches ON, do not operate the air conditioning packs in HIGH for takeoff, approach or landing.

Note: The fire protection Non-Normal procedures take precedence over the statement regarding no air conditioning pack in HIGH during takeoff, approach, or landing. The CARGO FIRE and SMOKE/ FUMES REMOVAL checklists require the operating PACK switch(es) HIGH. Switch(es) need to be placed in HIGH in order to increase ventilation for smoke removal.

Autopilot/Flight Director System

AFM Limitations

Use of aileron trim with the autopilot engaged is prohibited.

Do not engage the autopilot for takeoff below 400 feet AGL.

Airplanes operating under FAA Rules:

For single channel operation during approach, the autopilot shall not remain engaged below 50 feet AGL.

Maximum allowable wind speeds when landing weather minima are predicated on autoland operations:

- Headwind 25 knots
- Crosswind 20 knots
- Tailwind 10 knots.

Maximum and minimum glideslope angles for autoland are 3.25 degrees and 2.5 degrees, respectively.

Autoland capability may only be used with Flaps 30 or 40 and both engines operative.

Non–AFM Operational Information

Do not use LVL CHG on final approach below 1000 feet AFE.

Communications

Non-AFM Operational Information

Use the VHF radio connected to the top of fuselage antenna for primary ATC communications on the ground.

Aircraft Communications Addressing and Reporting System (ACARS)

The ACARS is limited to the transmission and receipt of messages that will not create an unsafe condition if the message is improperly received, such as the following:

- The message or parts of the message are delayed or not received,
- The message is delivered to the wrong recipient, or
- The message content may be frequently corrupted.

However, Pre-Departure Clearance, Digital Automatic Terminal Information Service, Oceanic Clearances, Weight and Balance, and Takeoff Data messages can be transmitted and received over ACARS if they are verified per approved operational procedures.

Electrical

AFM Limitations

The use of Flight Deck Auxiliary Power outlets in the flight deck requires operational regulatory approval.

Engines and APU

AFM Limitations

Thrust

Operation with assumed temperature reduced takeoff thrust is not permitted with anti-skid inoperative.

Engine Limit Display Markings

Maximum and minimum limits are red.

Caution limits are amber.

Engine Ignition

Engine ignition must be on for:

- takeoff
- landing
- operation in heavy rain
- anti-ice operation.

Engines – Reverse Thrust

Use for ground operation only. Intentional selection of reverse thrust in flight is prohibited. Backing the airplane with the reverse thrust is prohibited. Do not attempt go-around after thrust reverser deployment on landing.

APU

Airplanes operating under FAA Rules: Inflight - APU bleed + electrical load: Maximum altitude 10,000 feet.

Airplanes operating under FAA Rules: Ground only - APU bleed + electrical load: Maximum altitude 15,000 feet.

APU bleed: Maximum altitude 17,000 feet.

APU electrical load: Maximum altitude 41,000 feet.

Non-AFM Operational Information

APU bleed valve must be closed when:

- ground air connected and isolation valve is open
- engine no. 1 bleed valve is open
- isolation and engine no. 2 bleed valves open.

APU bleed valve may be open during engine start, but avoid engine power above idle.

After three consecutive aborted start attempts, a 15-minute cooling period is required.

Run the APU for two full minutes before using it as a bleed air source.

Flight Controls

AFM Limitations

The maximum altitude with flaps extended is 20,000 feet.

Holding in icing conditions with flaps extended is prohibited.

In flight, do not extend the speed brake lever beyond the FLIGHT detent. Do not use speed brakes below 1000 feet above the surface.

In flight, do not extend the speedbrake lever beyond the ARMED detent with flaps 40 selected.

Avoid rapid and large alternating control inputs, especially in combination with large changes in pitch, roll, or yaw (e.g., large side slip angles) as they may result in structural failure at any speed, including below VA.

Non-AFM Operational Information

Do not deploy the speedbrakes in flight at radio altitudes less than 1,000 feet.

Alternate flap duty cycle:

- When extending or retracting flaps with the ALTERNATE FLAPS position switch, allow 15 seconds after releasing the ALTERNATE FLAPS position switch before moving the switch again to avoid damage to the alternate flap motor clutch
- After a complete extend/retract cycle, i.e., 0 to 15 and back to 0, allow 5 minutes cooling before attempting another extension.

Flight Management, Navigation

AFM Limitations

Air Data Inertial Reference Unit (ADIRU)

ADIRU alignment must not be attempted at latitudes greater than 78 degrees 15 minutes.

All flight operations based on magnetic heading or magnetic track angle are prohibited in geographic areas where the installed IRS MagVar table errors are greater than 5 degrees.

Refer to Operating Data/Inertial Reference System (IRS) section of AFM for procedures to determine the geographic areas and magnitude of MagVar errors for the specific MagVar table installed in the IRS and if any of these limitations apply.

For Fail-Operational Autopilot, all autopilot/flight director ILS (and GLS if installed) approach and landing operations that use magnetic north referenced courses or bearings are prohibited in geographic areas where the installed IRS MagVar table errors are greater than 3 degrees.

Look-Ahead Terrain Alerting (GPWS)

Do not use the terrain display for navigation.

Do not use the look-ahead terrain alerting and terrain display functions:

- within 15 nm of takeoff, approach or landing at an airport or runway not contained in the GPWS terrain database.

Note: Refer to Honeywell Document 060-4267-000 for airports and runways contained in the installed GPWS terrain database.

Overrun Warning (ORW) Alerting System

(as installed)

The ORW alerting system does not replace the requirement to conduct an en route landing distance performance assessment prior to landing. The lack of an overrun alert does not guarantee the airplane can stop prior to reaching the runway end.

If the In-Air Overrun Warning (“OVERRUN, GO-AROUND”) occurs during approach, execute an immediate go-around.

Inhibit the overrun alert when:

- Landing OAT on the ground is below –40°C or greater than 50°C; or
- Gross Weight is greater than Maximum Landing Weight.

Non-AFM Operational Information

Avoid weather radar operation in a hangar.

Avoid weather radar operation when personnel are within the area normally enclosed by the aircraft nose radome.

Note: The hangar recommendation does not apply to the weather radar test mode.

Broadband Antenna RF Hazard

Note: Broadband system must be OFF during aircraft de-icing, taxiing under a skybridge or while in a hangar.

Runway Awareness and Advisory System (RAAS)

(as installed)

Do not use RAAS callouts or alerts for navigation.

Do not use RAAS callouts or alerts as a substitute for NOTAM or ATIS information.

Fuel System

AFM Limitations

Maximum tank fuel temperature is 49°C.

Minimum tank fuel temperature prior to takeoff and inflight is –43°C, or 3°C above the fuel freezing point temperature, whichever is higher.

Note: The use of Fuel System Icing Inhibitor additives does not change the minimum fuel tank temperature limit.

Intentional dry running of a center tank fuel pump (low pressure light illuminated) is prohibited.

Fuel Balance

Lateral imbalance between main tanks 1 and 2 must be scheduled to be zero. Transient fuel imbalance must not exceed 453 kilograms for taxi, takeoff, flight or landing.

Fuel Loading

Main tanks 1 and 2 must be full if center tank contains more than 453 kilograms.

Landing Gear

Non-AFM Operational Information

Do not apply brakes until after touchdown.

Normal Procedures — Chapter NP
Introduction — Section 11

General

This chapter gives:

- an introduction to the normal procedures philosophy and assumptions
- step by step normal procedures.

Normal Procedures Philosophy and Assumptions

Normal procedures verify for each phase of flight that:

- the airplane condition is satisfactory
- the flight deck configuration is correct.

Normal procedures are done on each flight. Refer to the Supplementary Procedures (SP) chapter for procedures that are done as needed, for example the adverse weather procedures.

Normal procedures are written for a trained flight crew and assume:

- all systems operate normally
- the full use of all automated features (LNAV, VNAV, autoland, autopilot, and autothrottle). This does not preclude the possibility of manual flight for pilot proficiency where allowed

Normal procedures also assume coordination with the ground crew before:

- hydraulic system pressurization, or
- flight control surface movement, or
- airplane movement.

Normal procedures do not include steps for flight deck lighting and crew comfort items, they are done by memory and scan flow. The panel illustration in this section shows the scan flow. The scan flow sequence may be changed as needed by company policy.

In order to avoid misunderstandings or misinterpretations some words in this manual are to be defined as:

MUST: it is an obligation. Something that has to be done. Do not deviate from a MUST state.

SHOULD: it is used to show when something is likely or expected. Normally refers to a policy or safety state.

RECOMMENDED: it is used to show when something is likely or expected. Normally refers to an operational efficiency or a better comfort.

MAY or CAN: it is used with situations where the pilot will decide the best course of action in accordance with company’s policies.

Configuration Check

It is the crew member’s responsibility to verify correct system response. Before engine start, use system lights to verify each system's condition or configuration. After engine start, the master caution system alerts the crew to warnings or cautions away from the normal field of view.

If there is an incorrect configuration or response:

- verify that the system controls are set correctly
- check the respective circuit breaker as needed. Maintenance must first determine that it is safe to reset a tripped circuit breaker on the ground
- test the respective system light as needed

Before engine start, use individual system lights to verify the system status. If an individual system light indicates an improper condition:

- check the Minimum Equipment List to determine if the condition has a dispatch effect
- decide if maintenance is needed

If, during or after engine start, a red warning or amber caution light illuminates:

- do the respective non-normal checklist (NNC)
- on the ground, check the Minimum Equipment List

If, during recall, an amber caution illuminates and then extinguishes after a master caution reset:

- check the Minimum Equipment List
- the respective non-normal checklist is not needed

Crew Duties

Airmanship has been described as “Aviation Common Sense”. It is a concept which combines a pilot’s professionalism, aviation knowledge, maturity and self-awareness in its definition. It is the bedrock of a safe and efficient pilot.

Airmanship and Guidance will be displayed in Italics to give it a distinct look in the document.

Preflight and postflight crew duties are divided between the captain (C) and first officer (F/O). Phase of flight duties are divided between the Pilot Flying (PF) and the Pilot Monitoring (PM).

Note: (C) is to be considered the pilot occupying the left seat and (F/O) the pilot occupying the right seat.

Each crewmember is responsible for moving the controls and switches in their area of responsibility:

- the phase of flight areas of responsibility for both normal and non-normal procedures are shown in the Area of Responsibility illustrations in this section. Typical panel locations are shown
- the preflight and postflight areas of responsibility are defined by the “Preflight Procedure - Captain” and “Preflight Procedure - First Officer.”

The captain may direct actions outside of the crewmember’s area of responsibility.

The general PF phase of flight responsibilities are:

- taxiing
- flight path and airspeed control
- airplane configuration
- navigation.

The general PM phase of flight responsibilities are:

- checklist reading
- communications
- tasks asked for by the PF
- monitoring taxiing, flight path, airspeed, airplane configuration and navigation.

PF and PM duties may change during a flight. For example, the captain could be the PF during taxi but be the PM during takeoff through landing.

Normal procedures show who does a step by crew position (C, F/O, PF, or PM):

- in the procedure title, or
- in the far right column, or
- in the column heading of a table

The mode control panel is the PF’s responsibility. When flying manually, the PF directs the PM to make the changes on the mode control panel.

The captain is the final authority for all tasks directed and done.

Control Display Unit (CDU) Procedures

Before taxi, the captain or first officer may make CDU entries. The other pilot must verify the entries.

Make CDU entries before taxi or when stopped, when possible. If CDU entries must be made during taxi, the PM makes the entries. The PF must verify the entries before they are executed.

In flight, the PM usually makes the CDU entries. The PF may also make simple, CDU entries when the workload allows. The pilot making the entries executes the change only after the other pilot verifies the entries.

During high workload times, for example departure or arrival, try to reduce the need for CDU entries. Do this by using the MCP heading, altitude, and speed control modes. The MCP can be easier to use than entering complex route modifications into the CDU.

Autopilot Flight Director System (AFDS) Procedures

The crew must always monitor:

- airplane course
- vertical path
- speed

When selecting a value on the MCP, verify that the respective value changes on the flight instruments, as applicable.

The crew must verify manually selected or automatic AFDS changes. Use the FMA to verify mode changes for the:

- autopilot
- flight director
- autothrottle

During LNAV and VNAV operations, verify all changes to the airplane’s:

- course
- vertical path
- thrust
- speed

Announcing changes on the FMA and thrust mode display when they occur is a good CRM practice and a company policy.

Scan Flow and Areas of Responsibility

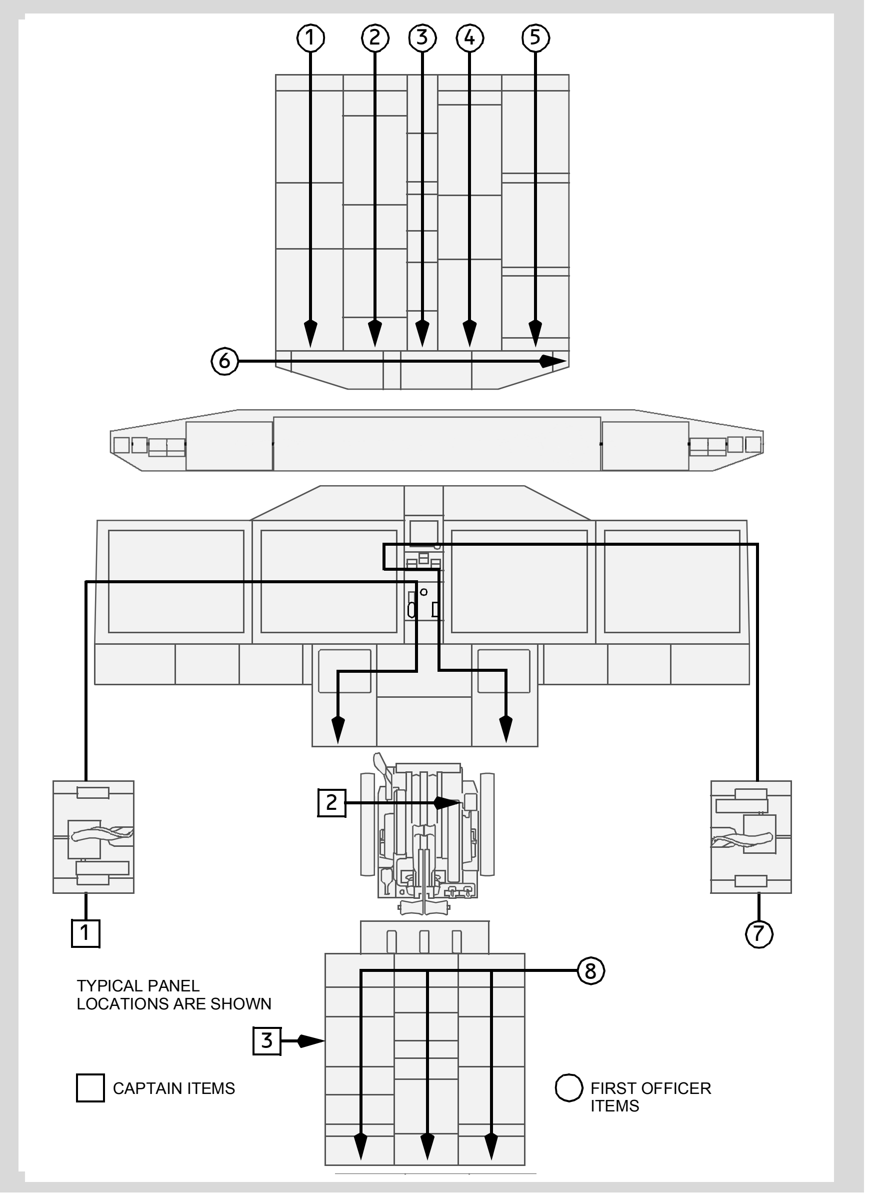
The scan flow and areas of responsibility diagrams shown below are representative and may not match the configuration(s) of company’s airplanes.

The scan flow diagram provides general guidance on the order each flight crew member should follow when doing the preflight, before start and postflight procedures. Specific guidance on the items to be checked are detailed in the amplified Normal Procedures.

Note: PF is responsible for joint responsibility items or can delegate to PM.

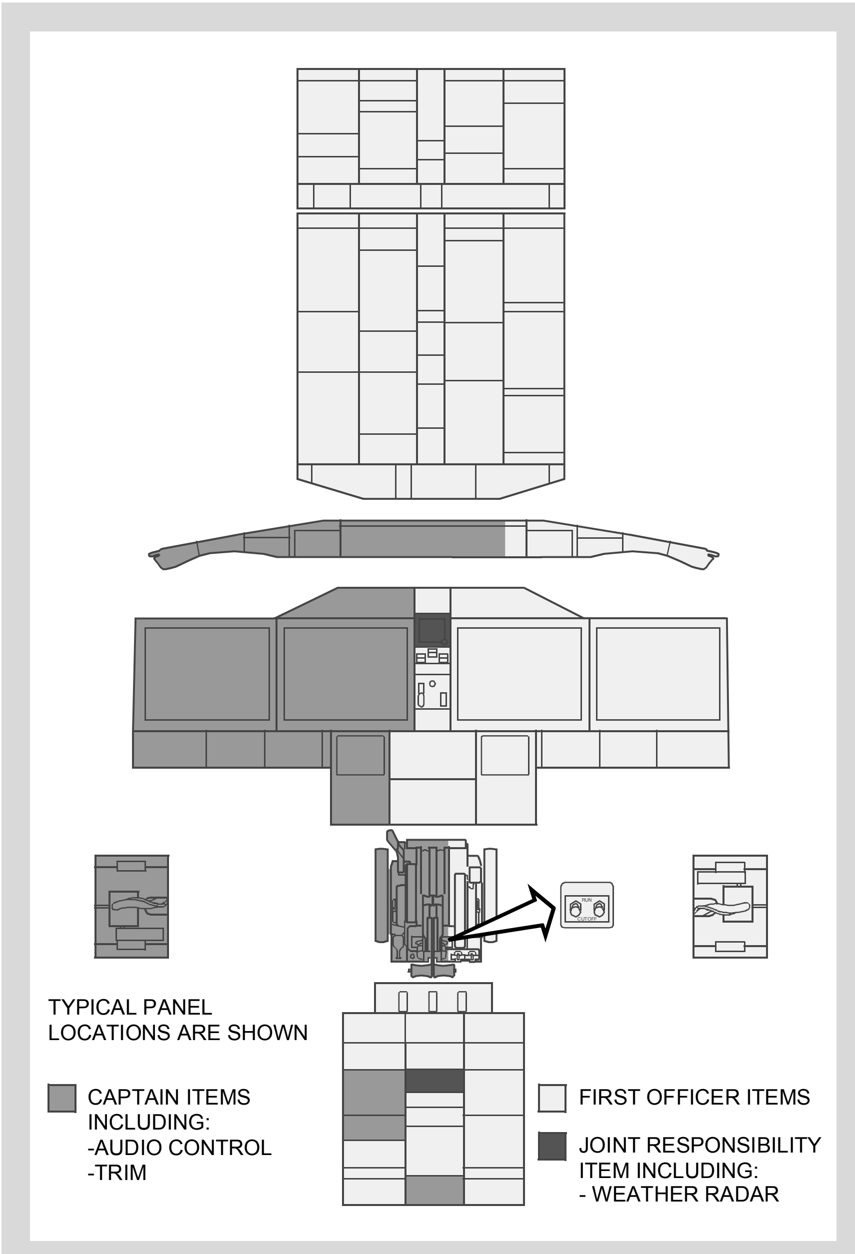
Preflight and Postflight Scan Flow

-MAX 8 fleet only



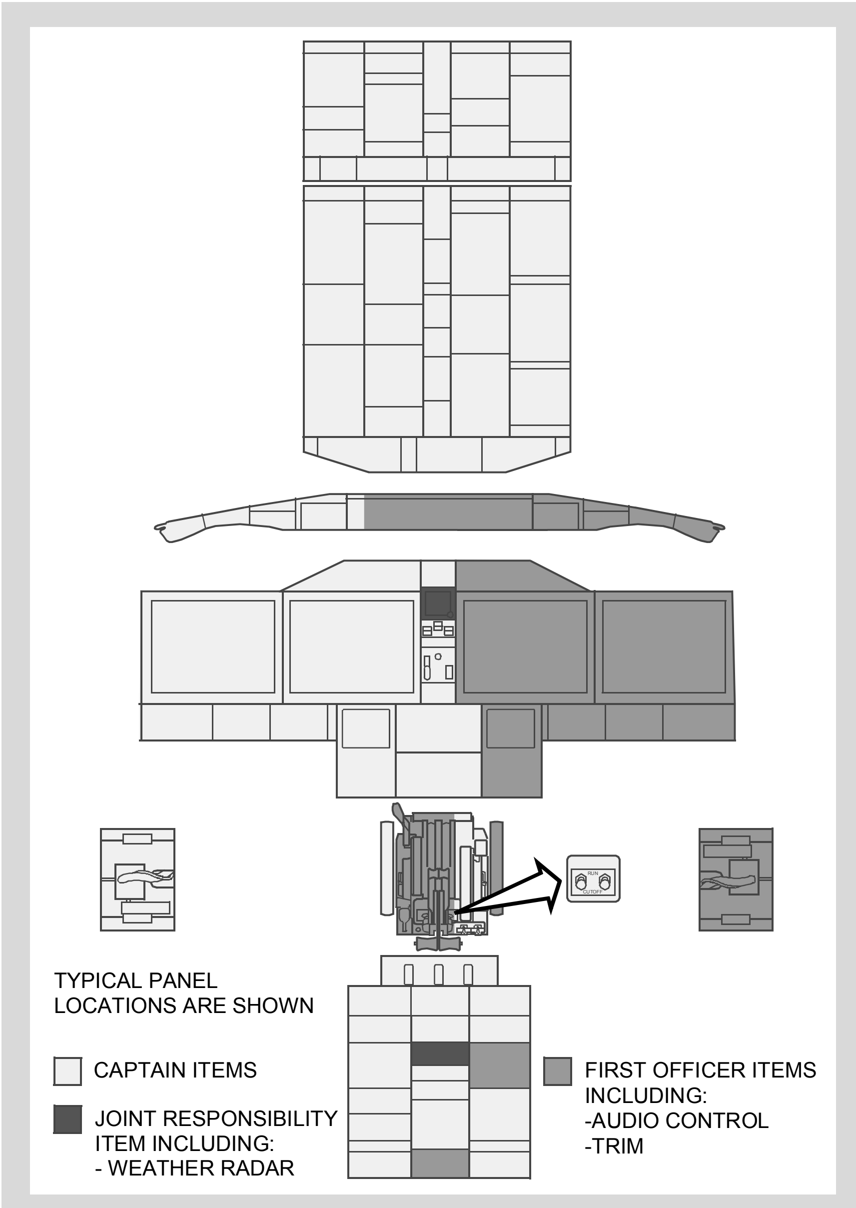
Areas of Responsibility - Captain as Pilot Flying or Taxiing

-MAX 8 fleet only:



Areas of Responsibility - First Officer as Pilot Flying

-MAX 8 fleet only:



Intentionally
Blank

Threats and errors associated with this phase of flight are:

- *Distractions;*
- *Interruption of procedures;*
- *Circuit breaker;*
- *Wing anti-ice ON;*
- *Rhyming responses to check-list;*

These items are not limited to and pilots are expected to anticipate any threat.

Preliminary Preflight Procedure – Captain

The Preliminary Preflight Procedure assumes that the Electrical Power Up supplementary procedure is complete.

Perform the following actions after a crew change, maintenance action or if the aircraft has been unattended for any period of time.

A full IRS alignment is recommended. If time does not allow a full alignment, do the Fast Realignment supplementary procedure.

IRS mode selectors .... OFF, then NAV

Verify that the ON DC lights illuminate then extinguish.

Verify that the ALIGN lights are illuminated.

Note:a few seconds after starting a full IRS alignment:

YAW DAMPER switch - ON;

Verify that the YAW DAMPER light is extinguished;

Verify that the following are sufficient for flight:

- Oxygen Pressure
- Hydraulic quantity
- Engine oil quantity

Aircraft Manuals .... Check

According to the area of responsibility.

Verify if the QRH and Normal Checklist correspond to the aircraft type.

Maintenance documents... Check

If necessary crosscheck any operational procedure on the MEL.

Flight deck door access system..Test

Verify if flight deck door operational system is working properly according to Flight Deck Door Access System Test Supplementary Procedures. This test is needed once per flight day.

Interphone / PA system ....Test

Check communication with flight attendants stations.

Preliminary Preflight Procedure – First Officer

Perform the following actions after a crew change, maintenance action or if the aircraft has been unattended for any period of time.

Aircraft Manuals .... Check

According to the area of responsibility.

Verify if the QRH and Normal Checklist correspond to the aircraft type.

Emergency equipment .... Check

Fire extinguisher - Checked and stowed

Crash axe - Stowed

Scape ropes - Stowed

PBE and Flashlights - Verify if installed

Life vests, Heat Resistant Gloves - Stowed

Smoke goggles (if applicable) - Stowed

ELT switch (as installed) .... Guard closed

Verify that the ELT light is extinguished.

MAX8 Fleet Only

ELEVATOR JAM LANDING ASSIST switch .... Guard Closed

MAX8 Fleet Only

MAINT light .... Verify extinguished

-700 and -800 Fleet Only

PSEU light .... Verify extinguished

GPS light .... Verify extinguished

ILS light (as installed) .... Verify extinguished

GLS light (as installed) .... Verify extinguished

SERVICE INTERPHONE switch .... OFF

AUDIO CONTROL PANEL (observer) .... Verify

Transmitter Selector switch in PA, and all others receivers closed and in minimum volume.

-700 and -800 Fleet Only

ENGINE panel .... Verify

Verify that the REVERSER lights are extinguished.

Verify that the ENGINE CONTROL lights are extinguished.

EEC switches - ON

Verify that the ALTERNATE lights are extinguished.

MAX8: Fleet Only

ENGINE panel .... Verify

Verify that the REVERSER COMMAND light is extinguished.

Verify that the REVERSER AIR/GRD light is extinguished.

Verify that the REVERSER LIMITED lights are extinguished.

Verify that the ENGINE CONTROL lights are extinguished.

EEC switches - ON

Verify that the ALTERNATE lights are extinguished.

Oxygen panel .... Set

Note: PASSANGER OXYGEN switch activation causes deployment of the passenger oxygens masks.

PASSENGER OXYGEN switch - Guard closed

Verify that the PASS OXY ON light is extinguished.

Landing gear indicator lights .... Verify illuminated

Flight recorder switch .... Guard closed

MACH AIRSPEED WARNING

TEST switches ....Push and hold one at time

Verify that the clacker sounds.

STALL WARNING TEST switches ....Push and hold one at time

Verify that each control column vibrates when the respective switch pushed.

Note: the stall warning test requires that AC transfer busses are powered for up to 4 minutes.

Note: with hydraulic power off, the leading edge flaps may droop enough to cause an asymmetry signal, resulting in a failure of the stall warning system test. Should this occur, obtain a clearance to pressurize the hydraulic system, place the “B” system electric pump ON and retract the flaps. When flaps are retracted repeat the test. At the completion of the test, turn the “B” system electric pump “OFF”.

INTERNET - SAT TX CONTROL switches (as installed) ..... Check

Verify that the “TRANSMIT” switch is illuminated “NORMAL”.

Verify that the “MUTE” switch is blanked.

Circuit breakers (P6 panel) .... Check

Manual gear extension access door .... Closed

Circuit breakers (control stand, P18 panel) .... Check

Note: check circuit breakers position carefully in flights after maintenance service or overnights. CBs may be found pulled due to maintenance action.

Exterior inspection - Captain or First Officer

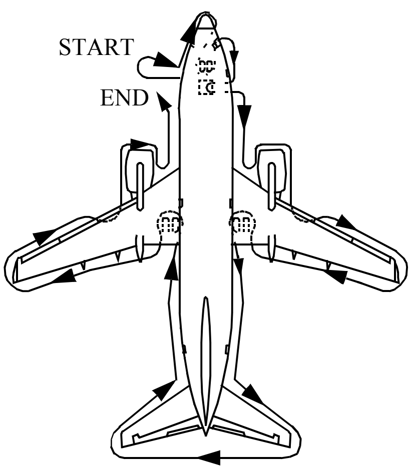
Perform on:

- The first flight of the crew on the aircraft;
- When the aircraft has been on the ground for three or more hours:
- Whenever returning after having left the aircraft unattended;
- Whenever the Pilot in Command decides it should be performed;
- If maintenance personnel did not perform it in a stopover.

Before starting the exterior inspection, check:

- LOGO light switch - ON (night flight);
- POSITION light switch - STEADY:
- ANTI-COLLISON light switch - OFF;
- WHEEL WELL light switch - ON (night flight);
- Landing Lights, Wing lights - OFF.

Inspection Route



Before each flight the Captain, First Officer and maintenance personnel must verify if the airplane is satisfactory for flight.

Items at each location may be checked in any sequence.

Use the detailed inspection route below to check that:

- The surface and structures are cleared, not damaged, not missing parts and there are no fluid leaks;

- The tires are not too worn, not damaged and there is no tread separation;
- The gear struts are not fully compressed; The engine inlets and tailpipes are clear, the access panels are secured, the exterior including the bottom of the nacelles, is not damaged and the reversers are stowed;
- The doors and access panels that are not in use are latched;
- The probes, vents, and static ports are cleared and not damaged;
- The skin area adjacent to the pitot probes and static ports is not wrinkled;
- The antennas are not damaged;
- The light lenses are clean and not damaged.

For cold weather operations see the Supplementary Procedures.

Note: fluid leaks from the engine drains are allowed provided the leaks are less than a continuous stream. Refer to the Engine Start Procedure for additional guidance.

Left Forward Fuselage

Probes, sensors, ports, vents and drains (as applicable) .... Check

Doors and access panels (not in use) ....Latched

Nose

Radome .... Check

Conductor straps ....Secure

Forward EE door ....Secure

Nose Wheel Well

Tires and wheels .... Check

Exterior light .... Check

Gear strut and doors .... Check

Nose wheel steering assembly .... Check

Nose gear steering lockout pin ....As needed

Gear pin ....As needed

Nose wheel spin brake (snubber) ....In place

Right forward fuselage

Probes, sensors, ports, vents and drains (as applicable) .... Check

Oxygen pressure relief green disc ....In place

Doors and access panels (not in use) ....Latched

Right Wing Root, Pack, and Lower Fuselage

Ram air deflector door .... Extended

Pack and pneumatic access doors ....Secure

Probes, sensors, ports, vents and drains (as applicable) .... Check

Exterior lights .... Check

Leading edge flaps .... Check

Number 2 Engine

Exterior surfaces (including the bottom of the nacelles) ....Check for damage

Access panels ....Latched

Probes, sensors, ports, vents and drains (as applicable) .... Check

Fan blades, probes and spinner .... Check

Thrust reverser .... Stowed

Exhaust area and tailcone .... Check

Right Wing and Leading Edge

Access panels ....Latched

Leading edge flaps and slats .... Check

Fuel measuring sticks ....Flush and Secure

Wing Surfaces .... Check

Fuel tank vent .... Check

Right Wing Tip and Trailing Edge

Position and strobe lights .... Check

Static discharge wicks .... Check

Aileron and trailing edge flaps .... Check

Right Main Gear

Tires, brakes and wheels .... Check

Verify that the wheel chocks are in place as needed.

If the parking brake is set, the brake wear indicator pins must extend out of the guides.

Gear strut, actuators and doors .... Check

Hydraulic lines ....Secure

Gear pin ....As needed

Right Main Wheel Well

APU FIRE CONTROL handle ....Up

NGS operability indicator light (as applicable) .... Check

Verify that the light is green.

Wheel Well .... Check

Right Aft Fuselage

Doors and access panels (not in use) ....Latched

Negative pressure relief door .... Closed

Outflow valve .... Check

Probes, sensors, ports, vents and drains (as applicable) .... Check

APU air inlet ....Open

Tail

Vertical stabilizer and rudder .... Check

Elevator feel probes .... Check

Tail skid (as installed) .... Check

Verify that the tail skid is not damaged.

Verify that the tail skid is in the retracted position.

Horizontal stabilizer and elevator .... Check

Static discharge wicks .... Check

Strobe lights .... Check

APU cooling inlet and exhaust outlet .... Check

Left Aft Fuselage

Doors and access panels (not in use) ....Latched

Probes, sensors, ports, vents and drains (as applicable) .... Check

Left Main Gear

Tires brakes and wheels .... Check

Verify that the wheel chocks are in place as needed.

If the parking brake is set, the brake wear indicator pins must extend out of the guides.

Gears strut, actuators and doors .... Check

Hydraulics lines ....Secure

Gear pin ....As needed

Left Main Wheel Well

Wheel well .... Check

Engine fire bottle pressure .... Check

Left Wing Tip and Trailing Edge

Aileron and trailing edge flaps .... Check

Static discharge wicks .... Check

Position and strobe lights .... Check

Left Wing and Leading Edge

Fuel tank vent .... Check

Wing surfaces .... Check

Fuel measuring sticks ....Flush and Secure

Leading edge flaps and slats .... Check

Access panels ....Latched

Number 1 Engine

Exhaust area and tailcone .... Check

Thrust reverser .... Stowed

Fan blades, probes and spinner .... Check

Probes, sensors, ports, vents and drains (as applicable) .... Check

Access panels ....Latched

Exterior surfaces (including the bottom of the nacelles) ....Check for damage

Left Wing Root, Pack and Lower Fuselage

Leading edge flaps .... Check

Probes, sensors, ports, vents and drains (as applicable) .... Check

Exterior lights .... Check

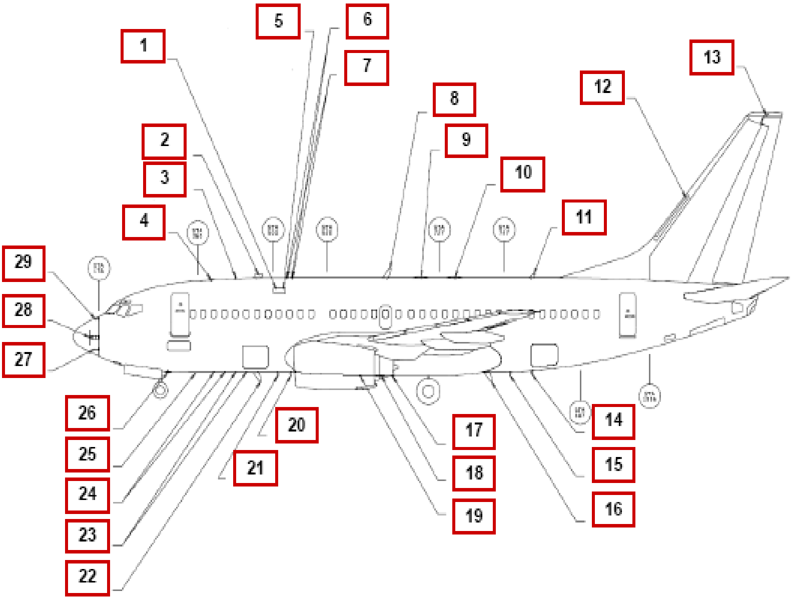
Pack and pneumatic access doors ....Secure

Ram air deflector door .... Extended

In return from the exterior inspection:

Exterior lights - as required

Aircraft Wiring Diagram



1- SATCOM High gain antenna
2- SATCOM Low gain antenna
3- ATC Top
4- TCAS Antenna top
5- SATCOM High gain antenna
6- GPS Sensor unit
7- GPS Antenna
8- VHF No. 1/2 (depending on acft)
9- ADF Sense / loop No. 1
10- ADF Sense / loop No. 2
11- ELT
12- HF No. 1 / 2
13- VOR
14- TFTS / Airphone antenna No. 2
15- TFTS / Airphone antenna No. 1
16- VHF No. 1/2 (depending on acft)
17- DME NO. 2
18- Marker beacon
19- DME no. 1
20- TFTS / Airphone antenna No. 2
21- TFTS / Airphone antenna No. 1
22- VHF no. 3
23- Radio altimeter No. 1
24- Radio altimeter No. 2
25- ATC Bottom
26- TCAS Antenna bottom
27- AFCS Localizer
28- Weather radar
29- Glide slope

CDU Preflight Procedure - Captain and First Officer

The initial data entries must be complete before the flight instrument check during the Preflight Procedure.

The Navigation and Performance Data entries must be complete prior to the reading of the before Start Checklist.

The Captain or First Officer may make CDU entries. The other pilot must verify the entries.

Enter data in all the boxed items on the following CDU pages.

Enter data in the dashed items or modify small font items that are listed in this procedure. Enter or modify other items at pilot's discretion.

Failure to enter enroute winds may result in flight plan time and fuel burn errors.

> **Note:** if time allows, set the wind shown on FPL on wind and temperature Summary Table for each navigation fix/position. If the flight is short, set the TOC wind in the CRZ / WIND (Perf Init Page).

Initial Data .... Set

IDENT page:

Verify that the MODEL is correct.

Verify that the ENG RATING is correct.

Verify that the navigation database ACTIVE data range is current. If not, select the current database, or call maintenance in order to update the navigation database.

POS INIT page:

Verify that the time is correct.

Enter the present position on the SET IRS POS line.

Use the most accurate latitude and longitude Navigation Data.

Note: use GPS position, if available:

FMC - POS INIT page 2.

Preflight Procedures - Captain

Objective: to check and configure aircraft systems.

Do the following procedures when any of the following criteria is met:

- First flight;
- After crew change or maintenance action;
- If the aircraft has been unattended for any period of time;
- After Secure Checklist reading.

The Captain normally does this procedure. The First Officer may perform this procedure if needed.

Lights ....Test

Master LIGHTS TEST and DIM switch - TEST

The fire warning lights are not checked during this test. Use individual test switches or push to test features to check lights which do not illuminated during the light test. Use scanflow to verify that all other lights are flashing or illuminated. Verify that all system annunciator panel lights are illuminated.

Master LIGHTS TEST and DIM switch - As Needed

Electronic Flight Bag (EFB) ....ON

Verify if the EFB battery is minimum 50% and charging.

Verify internet connectivity (3G/4G or WiFi).

Check for applications updates (Aviator, OPT, Flight Deck).

Oxygen ....Test and Set

Note the crew oxygen pressure. Verify if it is sufficient for dispatch.

Oxygen mask stowed and door closed

TEST / RESET switch push and hold

Verify that the yellow cross shows momentarily in the flow indicator.

Regulator selector (as installed) Rotate to EMER

Mask/Boom switch - Mask

FLT INT switch - Push

SPKR switch - ON

TEST/RESET switch - Push and hold

EMERGENCY/Test Selector (as installed) - Push and hold

Advise any maintenance personnel using the FLT Interphone that a test will be done on this communication channel.

Simultaneously push the Push-to-Talk switch, the EMERGENCY/Test selector (if installed) and the RESET/TEST switch.

Verify oxygen flow sound is heard thought the flight deck speaker.

Push-to-Talk switch - Release

TEST/RESET switch - Release

Mask/Boom switch - BOOM

EMERGENCY/TEST selector - Push and hold

If applicable: Regulator selector - Rotate to EMER

Continue to hold the TEST/RESET switch down and push the EMERGENCY/TEST (if applicable) selector for 5 seconds. Verify that the yellow cross shows continuously in the flow indicator.

Verify that the crew oxygen pressure does not decrease more than 100 psi.

If the oxygen cylinder valve is not in the full open position, pressure can:

Decrease rapidly, decrease more than 100 psi or increase slowly back to normal.

Release the TEST/RESET switch and the EMERGENCY/TEST selector (if applicable). Verify that the yellow cross does not show in the flow indicator.

Regulator selector (as installed) - Rotate to 100%

Normal/100% selector - 100%

Crew oxygen pressure - Check

Clock .... Set

TIME/DATE pushbutton .... UTC time

-700 and -800 Fleets Only

NOSE WHEEL STEERING switch .... Guard closed

Display selector panel .... Set

MAIN PANEL DISPLAY UNITS selector - NORM

LOWER DISPLAY UNIT selector - NORM

TAKEOFF CONFIG light (as installed) .... Verify extinguished

CABIN ALTITUDE light (as installed) .... Verify extinguished

Disengage light TEST switch .... Hold to 1

Verify that the A/P light is illuminated steady amber.

Verify that the A/T light is illuminated steady amber.

Verify that the FMC light is illuminated steady amber.

Disengage light TEST switch .... Hold to 2

Verify that the A/P light is illuminated steady red.

Verify that the A/T light is illuminated steady red.

Verify that the FMC light is illuminated steady amber.

STAB OUT OF TRIM light .... Verify extinguished

Do the Initial Data from the CDU Preflight Procedure and verify that the IRS alignment is complete before checking the flight instruments.

Flight Instruments .... Check

Verify that the flight instruments indications are correct.

Note:verify altimeter for RVSM limits.

Verify that only this flags are shown:

- TCAS OFF
- NO VSPD until V-speeds are selected
- Expected RMI flags

Verify that the flight mode annunciations (FMA) are correct:

- Autothrottle mode is blank
- Roll mode is blank
- Pitch mode is blank
- AFDS status is FD

Select the map mode

Standby instruments (as installed) .... Check

Standby horizon .... Set

Gyro caging control .... Pull, then release

Approach mode selector .... OFF

Verify that the flight instrument indications are correct.

Verify that no flags are shown

Standby altimeter .... Set

Verify that the flight instrument indications are correct.

Verify that no flags are shown.

Integrated standby flight display (as installed) .... Set

Verify that the approach mode display is blank.

Set the altimeter.

Verify that the flight instrument indications are correct.

Verify that no flags or message are shown.

-700 and -800 Fleets Only

Standby RMI .... Set

Select either VOR or ADF.

SPEED BRAKE lever .... DOWN detent

Verify that the SPEED BRAKE ARMED light is extinguished.

Verify that the SPEED BRAKE DO NOT ARM light is extinguished

Verify that the SPEED BRAKE EXTENDED light is extinguished.

Note: to ensure the SPEED BRAKE is properly stowed, push down firmly on top of the speed brake handle.

Reverse thrust levers .... Down

Forward thrust levers .... Closed

FLAP lever .... Set

Set the flap lever to agree with the flap position.

Parking brake .... Set

Set the parking brake OFF if the aircraft is on chocks.

Verify that the parking brake warning light is illuminated if the parking brake is applied.

Note: do not assume that the parking brake will prevent airplane movement. Accumulator pressure can be insufficient. Check the Hydraulic Brake Pressure Indicator.

Engine start levers.. CUTOFF

STABILIZER TRIM cutout switches .... Normal

Seat ....Adjust

Use the handhold above the forward window for assistance when pulling the seat forward. Do not use the glareshield as damage can occur.

Adjust the seat for optimum eye reference.

Verify a positive horizontal (fore and aft) seat lock.

Rudder Pedals ....Adjust

Adjust the rudder pedals to allow full rudder and brake pedal movement.

Seat belt and shoulder harness ....Adjust

Note: shoulder harness must be used from engine start to at least 10.000 ft.

Call: “Preflight Checklist”

Preflight Procedures - First Officer

Objective: to check and configure aircraft systems.

Do the following procedures when any of the following criteria is met:

- First flight;
- After crew change or maintenance action;
- If the aircraft has been unattended for any period of time;
- After Secure Checklist reading.

The first officer normally does this procedure. The captain may do this procedure as needed.

Flight control panel .... Check

FLIGHT CONTROL switches - Guard closed

Verify that the flight control LOW PRESSURE lights are illuminated.

Flight SPOILER switches - Guard Closed

YAW DAMPER switch - ON

Verify that the YAW DAMPER light is extinguished.

Verify that the standby hydraulic LOW QUANTITY light is extinguished

Verify that the standby hydraulic LOW PRESSURE light is extinguished.

Verify that the STBY RUD ON light is extinguished.

ALTERNATE FLAPS master switch - Guard closed

ALTERNATE FLAPS position switch - OFF

Verify that the FEEL DIFF PRESS light is extinguished.

Verify that the SPEED TRIM FAIL light is extinguished.

Verify that the MACH TRIM FAIL light is extinguished.

Verify that the AUTO SLAT FAIL light is extinguished.

MAX8 Fleet Only

Verify that the SPOILERS light is extinguished.

NAVIGATION panel .... Set

VHF NAV transfer switch - NORMAL

IRS transfer switch - NORMAL

FMC source select switch - NORMAL

DISPLAYS panel .... Set

SOURCE selector - AUTO

CONTROL PANEL select switch - NORMAL

Fuel panel .... Set

Verify that the ENG VALVE CLOSED lights are illuminated dim.

Verify that the SPAR VALVE CLOSED lights are illuminated dim.

Verify that the FILTER BYPASS lights are extinguished.

CROSSFEED selector - Closed

Verify that the VALVE OPEN light is extinguished.

FUEL PUMP switches - OFF

Verify that the center tank fuel pump LOW PRESSURE lights are extinguished.

Verify that the main tank fuel pump LOW PRESSURE lights are illuminated.

Note: whenever the APU is running and AC electrical power is on the busses, turn on one fuel boost pump to supply fuel under pressure to the APU to extend the service life of its fuel control unit.

CAUTION: Do not operate the center tank fuel pumps with the flight deck unattended.

Electrical panel .... Set

BATTERY switch - Guard closed

AC/DC Meter Selector:

DC indicator in BAT.

AC indicator in STBY POWER.

CAB/UTIL power switch (as installed) - ON

IFE/PASS SEAT power switch (as installed) - ON

GALLEY power switch (as installed) - ON

STANDBY POWER switch - Guard closed

Verify that the STANDY PWR OFF light is extinguished.

Verify that the BAT DISCHARGE light is extinguished.

Verify that the TR UNIT light is extinguished.

Verify that the ELEC light is extinguished.

Generator drive DISCONNECT switches - Guards closed

Verify that the DRIVE lights are illuminated.

BUS TRANSFER switch - Guard closed

Verify that the TRANSFER BUS OFF lights are extinguished.

Verify that the SOURCE OFF lights are extinguished.

Verify that the GEN OFF BUS lights are illuminated.

Lavatory SMOKE light (as installed) .... Verify extinguished

EQUIPMENT COOLING switches .... NORM

Verify that the OFF lights are extinguished.

EMERGENCY EXIT LIGHTS switch .... Guard closed

Verify that the NOT ARMED light is extinguished.

Passenger signs .... Set

NO SMOKING switch (as installed) - ON

FASTEN BELTS switch - OFF

If the APU is running:

-MAX8 Fleet Only

Verify that the APU DOOR light is extinguished.

Verify that the APU LOW OIL PRESSURE light is extinguished.

Verify that the APU FAULT light is extinguished.

Verify that the APU OVERSPEED light is extinguished.

Windshield WIPER selectors .... PARK

Verify that the windshield wipers are stowed.

Note: do not operate the wipers on a dry windshield.

WINDOW HEAT switches ....ON

Position switches ON at least 10 minutes before takeoff.

Verify that the OVERHEAT lights are extinguished.

Verify that the ON lights are illuminated (except at high ambient temperatures, when some of the lights may not be illuminated).

PROBE HEAT switches .... AUTO

Verify that the all lights are illuminated.

WING ANTI-ICE switch ....OFF

-700 and -800 Fleet Only

Verify that the VALVE OPEN lights are extinguished.

MAX8 Fleet Only

Verify that the L VALVE and R VALVE lights are extinguished.

ENGINE ANTI-ICE switches ....OFF

MAX8 Fleet Only

Verify that the ENG ANTI-ICE lights are extinguished.

-700, -800 and MAX8 Fleets

Verify that the COWL ANTI-ICE lights are extinguished.

-700 and -800 Fleets Only

Verify that the COWL VALVE OPEN lights are extinguished.

MAX8 Fleet Only

Verify that the COWL VALVE lights are extinguished.

Hydraulic panel .... Set

ENGINE HYDRAULIC PUMPS switches - ON

Verify that the LOW PRESSURE lights are illuminated.

ELECTRIC HYDRAULIC PUMPS switches - OFF

Verify that the OVERHEAT lights are extinguished.

Verify that the LOW PRESURE lights are illuminated.

High altitude landing switch (as installed) ....As needed

Verify that the INOP light is extinguished.

Voice Recorder switch (as installed) .... Auto

Air conditioning panel .... Set

AIR TEMPERATURE source selector - As needed

Note: always monitor supply duct temperatures

TRIM AIR switch (as installed) - ON

Verify that the DUCT OVERHEAT or the ZONE TEMP lights (as installed) are extinguished.

Temperature selectors - As needed

RECIRCULATION FAN switch(es) - AUTO

Air conditioning PACK switches - As required

Note: if PACK use is desired, always operate both packs together. Switching one Pack AUTO and the other OFF causes a greater APU fuel flow.

ISOLATION VALVE switch - OPEN

Engine BLEED air switches - ON

If the APU is ON:

APU BLEED air switch - ON or OFF

Note: if temperature allows, switch the APU Bleed - OFF to reduce the APU fuel flow.

If APU Bleed is ON, verify that the DUAL BLEED light is illuminated.

If APU Bleed is OFF, verify that the DUAL BLEED light is extinguished.

-700 Fleet Only

Verify that the PACK TRIP OFF lights are extinguished.

-800 and MAX8 Fleets Only

Verify that the PACK lights are extinguished.

Verify that the WING-BODY OVERHEAT lights are extinguished.

-700 and -800 Fleets Only

Verify that the BLEED TRIP OFF lights are extinguished.

MAX8 Fleet Only

Verify that the BLEED lights are extinguished.

Note: if necessary refer to the Supplementary Procedures - Maximum Cooling on the Ground to help keep the airplane as cool as possible.

Cabin pressurization panel .... Check

Verify that the AUTO FAIL light is extinguished.

Verify that the OFF SCHED DESCENT light is extinguished.

Pressurization mode selector - AUTO

Verify that th ALTN light is extinguished.

Verify that the MANUAL light is extinguished.

Lighting panel .... Set

Retractable LANDING lights (as installed) - RETRACT

LANDING light switches - OFF

RUNWAY TURNOFF switches - OFF

TAXI light switch - OFF

ENGINE START switches .... OFF

Electronic Flight Bag (EFB) .... ON

Verify if the EFB battery is minimum 50% and charging.

Verify internet connectivity (3G/4G or WiFi).

Check for applications updates (Aviator, OPT, Flight Deck).

Oxygen .... Test and Set

Note the crew oxygen pressure.

Oxygen mask - Stowed and doors closed

TEST/RESET switch - Push and Hold

Verify that the yellow cross shows momentarily in the flow indicator.

MASK/BOOM switch - Mask

FLT INT switch - Push

SPKR switch - ON

TEST/RESET switch - Push and Hold

EMERGENCY/Test Selector (as installed) - Push and Hold

Advise any maintenance personnel using the FLT Interphone that a test will be done on this communication channel.

Simultaneously push the Push-to-talk switch, the EMERGENCY/Test selector (if installed) and the RESET/TEST switch.

Verify oxygen flow sound is heard through the flight deck speaker.

Push-to-talk switch - Release

TEST/RESET switch - Release

MASK/BOOM switch - BOOM

EMERGENCY/TEST selector - Push and Hold

As applicable: Regulator selector - Rotate to EMER

Continue to hold the TEST/RESET switch down and push the EMERGENCY/TEST (if applicable) selector for 5 seconds. Verify that the yellow cross shows continuously in the flow indicator.

Verify that the crew oxygen pressure does not decrease more than 100 PSI. If the oxygen cylinder valve is not in the full open position, pressure can:

- Decrease rapidly, decrease more than 100 PSI or increase slowly back to normal.

Release the TEST/RESET/ switch and the EMERGENCY/TEST selector (if applicable). Verify that the yellow cross does not show in the flow indicator.

Regulator selector (as installed) - Rotate to 100%

Normal/100% selector - 100%

Crew oxygen pressure - Check

Clock .... Set

TIME/DATE pushbutton (as installed) - UTC time

-700 and -800 Fleets Only

Display Select Panel .... Set

MAIN PANEL DISPLAY UNITS selector .... NORM

LOWER DISPLAY UNIT selector .... NORM

TAKEOFF CONFIG light (as installed) .... Verify extinguished

CABIN ALTITUDE light (as installed) .... Verify extinguished

Disengage light TEST switch .... Hold to 1

Verify that the A/P light is illuminated steady amber.

Verify that the A/T light is illuminated steady amber.

Verify that the FMC light is illuminated steady amber.

Disengage light TEST switch .... Hold to 2

Verify that the A/P light is illuminated steady red.

Verify that the A/T light is illuminated steady red.

Verify that the FMC light is illuminated steady amber.

-700 and -800 Fleets Only

Hydraulic brake pressure indicator .... Check

Note: check pressure in amber or green band. Indication within amber band is normal with hydraulic system "B" not pressurized.

Do the Initial Data and Navigation Data steps from the CDU Preflight procedure and verify that the IRS alignment is complete before checking the flight instruments.

Flight instruments .... Check

Verify that the flight instruments indications are correct.

Note:verify main altimeters for RVSM limits.

Verify that the only these flags are shown:

- TCAS OFF;
- NO VSPD until V speeds are selected;
- Expected RMI flags.

Verify that the flight mode annunciation (FMA) are correct:

- Autothrottle mode is blank;
- Roll mode is blank;
- Pitch mode is blank;
- AFDS status is FD.

Select the map mode.

MAX8 Fleet Only

Display Select panel.. Set

Display Selector switch - PFD/MFD NORMAL

GROUND PROXIMITY panel .... Check

FLAP INHIBIT switch - Guard Closed

GEAR INHIBIT switch - Guard Closed

TERRAIN INHIBIT switch (as installed) - Guard Closed

Verify that the GROUND PROXIMITY INOP light is extinguished.

Landing gear panel .... Set

LANDING GEAR lever - Down

Verify that the green landing gear indicator lights are illuminated.

Verify that the red landing gear indicator lights are extinguished.

MAX8 Fleet Only

NOSE WHEEL STEER switch.................................... Guard Closed

MAX8 Fleet Only

FUEL FLOW switch .... Rate

Move switch to RESET then RATE.

MAX8 Fleet Only

Left SELECTOR switch C

MAX8 Fleet Only

Hydraulic brake pressure indicator .... Check

Note: check pressure in amber or green band. Indication within amber band is normal with hydraulic system “B” not pressurized.

-700 and -800 Fleets Only

Engine display control panel .... Set

N1 SET selector .... AUTO

SPEED REFERENCE selector .... AUTO

MAX8 Fleet Only

ENG TRF .... Set

Set engine indications on captains side.

MAX8 Fleet Only

Right SELECTOR switch C

Overheat and fire protection panel .... Check

Do this check on the first flight in the aircraft if the flight crew did not do the Electrical Power Up supplementary procedure.

Verify that the engine No. 1, APU, and engine No. 2 fire switches are in.

Alert ground personnel before the following test is accomplished:

OVERHEAT DETECTOR switches - NORMAL

TEST switch - Hold to FAULT/INOP

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Verify that the FAULT light is illuminated.

If the FAULT light fails to illuminate, the fault monitoring system is inoperative.

Verify that the APU DET INOP light is illuminated.

Do not run the APU if the APU DET INOP light does not illuminate.

Note: the fire warning light flashes and the horn sounds on the APU ground control panel when this test is done with the APU running. This can be mistaken by the ground crew as an APU fire.

TEST Switch - Hold to OVHT/FIRE

Verify that the fire warning bell sounds.

Verify that the master FIRE WARN lights are illuminated.

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Master FIRE WARN light - Push

Verify that the master FIRE WARN lights are extinguished.

Verify that the fire warning bell cancels.

Verify that the engine No. 1, APU and engine No. 2 fire switches stay illuminated.

Verify that the engine No. 1 and engine No. 2 start levers stay illuminated (as installed).

Verify that the ENG 1 OVERHEAT and ENG 2 OVERHEAT lights stay illuminated.

Verify that the WHEEL WELL light stays illuminated.

EXTINGUISHER TEST switch - Check

TEST switch - Position to 1 and hold

Verify that the three green extinguisher test lights are illuminated.

TEST switch - Release

Verify that the three green extinguisher test lights are extinguished.

Repeat for test position 2.

CARGO FIRE panel .... Check

DETECTOR SELECT switches - NORM

TEST switch - Push

Verify that the fire warning bell sounds.

Verify that the master FIRE WARN lights are illuminated.

Master FIRE WARN light - Push

Verify that the master FIRE WARN lights are extinguisher.

Verify that the fire warning bell cancels.

Verify that the FWD and AFT lights stay illuminated.

Verify that the green EXTINGUISHER test lights stay illuminated.

Verify that the DETECTOR FAULT light stays extinguished.

Verify that the DISCH light stay illuminated.

Radio tuning panel or VHF communication radios .... Set

Verify that the Offside Tuning Light is extinguished (as installed).

Note: VHF 1: select to ATC frequency.

VHF 2: select to company communication or ATIS.

VHF 3: select DATA in the frequency indicator on airplanes with ACARS, tuning above maximum or below minimum frequency.

Push the VHF 3 Radio Tuning Panel switch OFF.

WARNING: Do not key the HF radio while airplane is been fueled. Injury to personnel or fire can occur.

WEATHER RADAR control panel .... Set

Note: perform WX Radar Test on the first flight in the aircraft.

STABILIZER TRIM override switch .... Guard closed

WARNING: Do not put objects between the seat and the aisle stand. Injury can occur when the seat is adjusted.

Seat .... Adjust

Use the hand hold above the forward window for assistance when pulling the seat forward. Do not use the glareshield as damage can occur.

Adjust the seat for optimum eye reference.

Verify a positive horizontal (fore and aft) seat lock.

Rudder Pedals .... Adjust

Adjust the rudder pedals to allow full rudder and brake pedal movement.

Seat belt and shoulder harness .... Adjust

Note: shoulder harness must be used from engine start to at least 10.000 ft.

Do the “Preflight Checklist” on captain’s command.

Preflight Checklist

(C): Request "Preflight checklist"

(F/O): Do (read aloud) the requested checklist.

PREFLIGHT		
OXYGEN	TESTED, 100%	(BOTH)
NAV. TRANSFER & DISPLAY SWITCHES	NORMAL & AUTO	(F/O)
WINDOW HEAT	ON	(F/O)
PRESSURIZATION MODE SELECTOR	AUTO	(F/O)
FLIGHT INSTRUMENTS	HEADING ___ ALTIMETER ___	(BOTH)
ENGINE START LEVERS	CUTOFF	(C)

(F/O): Inform "Preflight Checklist Completed"

Note: Preflight checklist must be done when any of the following criteria is met:

- First flight;
- After crew change or maintenance action;
- If the aircraft has been unattended for any period of time;
- After Secure Checklist reading.

Before start procedures

Objective: to configure the aircraft for each flight.

Threats and errors associated with this phase of flight are:

- *Time pressure;*
- *MCP setting;*
- *Flight documentation;*
- *Minimum Equipment List (MEL) items;*
- *Rhyming rejected takeoff briefing;*
- *OPT last minute changes.*

These items are not limited to and pilots are expected to anticipate any threat.

On through flight procedures, verify:

- IRS alignment procedure is completed.
- Oxygen pressure;
- Hydraulic quantity;
- Engine oil quantity.

Scan flow must be made to ensure proper systems configuration.

Crew may anticipate the following actions however must check data when flight planning is available.

Cabin pressurization panel . ... Set (F/O)

FLIGHT ALTITUDE indicator - Set

Set cruise altitude.

LANDING ALTITUDE indicator - Set

Set destination field elevation.

Note: if airport elevation is above 6.000 ft check the Supplementary Procedures.

IGNITION select switch . ...IGN R (F/O)

Alternate the ignition select switch on each flight.

Lighting panel . ... Set (F/O)

LOGO light switch - As needed

Note: ON for night flights.

POSITION light switch - As needed

Note: STEADY on all night flights, daytime on international flights or when visibility is less than 2000 meters.

ANTI-COLLISION light switch - OFF

WING illumination switch - OFF

WHEEL WELL light switch - OFF

EFIS control panel . ...Set (C, F/O)

MINIMUMS reference selector - BARO

MINIMUMS selector - Set thrust reduction altitude.

FLIGHT PATH VECTOR switch - As needed

Note: Flight Path Vector may be used at pilot's discretion.

MAX8 Fleet Only

VSD switch - As needed

METERS switch - As needed

BAROMETRIC reference selector - IN or HPA

BAROMETRIC selector - Set local altimeter setting

VOR / ADF switches - As needed

Mode selector - MAP

CENTER switch - As needed

Range selector - As needed

TRAFFIC switch - Select TFC

WEATHER RADAR - OFF

Verify that the weather radar indications are not shown on the MAP.

MAP switches - As needed

Mode control panel . ...Set (C, F/O)

COURSE - set left course to first VOR radial to be intercepted or according to the airway course (if known).

FLIGHT DIRECTOR switches - ON

Move the switch for the pilot flying to ON first.

Bank Angle selector - As needed

HDG Selector - Normally set to runway heading (if known).

Autopilot DISENGAGE bar - UP

EFB . ...ON and updated (C, F/O)

-MAX 8 EB1 fleet
RUNWAY INHIBIT . ...INHIBIT (F/O)

AUTOBRAKE select switch. ....RTO (F/O)

Verify that the AUTOBRAKE DISARM light is extinguished.

ANTISKID INOP light . ... Verify extinguished (F/O)

FUEL FLOW switch . ... Rate (F/O)

Move switch to RESET then RATE.

Engine instruments . ...Check (C, F/O)

MFD - SYS . ...PUSH SYS

Verify hydraulic quantity, no RF shown.

MFD - ENG . ...PUSH ENG

Verify that the primary and secondary engine indications show existing conditions and no exceedance.

Note: verify engine oil quantity. A minimum of 70% or 15 quarts is necessary for dispatch.

Radio tunning panel or VHF communication radios. .....Set (C, F/O)

Verify that the Offside Tuning Light is extinguished (as installed).

VHF NAVIGATION radios . ...Set for departure (C, F/O)

Audio control panel . ...Set (C, F/O)

WARNING: Do not key the HF radio while the airplane is being fueled. Injury to personnel can occur.

CAUTION: Do not put objects between the seat and the aisle stand. Injury can occur when seat is adjusted.

TRANSPONDER panel . ... Set (F/O)

Note: set transponder switches according to master flight director switch. Left Master Flight Director: 1. Right Flight Director: 2.

CDU ....Set (C, F/O)

Navigation Data - Set

ROUTE page:

- enter the ORIGIN/Enter the route.

Note: enter company route if available.

Enter the FLIGHT NUMBER.

Note: flight number must be filled **GLOXXXX.**

Activate and execute the route.

DEPARTURES page:

- Select the runway and departure routing;
- Execute the runway and departure routing.

FMC Route Verification Techniques: After entering the route into the FMC, the crew should verify that the entered route is correct, comparing:

- The FPL with the airways and waypoints on the ROUTE pages;
- The FPL total distance and estimated fuel remaining with the FMC calculated distance and fuel remaining at the destination on the PROGRESS page.

When inserting SID, check waypoints with altitude restrictions, especially those with minimum and maximum altitude.

Note: always check CDU routing with clearance given by ATC.

ROUTE 2 (if installed): enter departure contingency when published If such procedure is unavailable, enter a departure and route from a runway other than the active runway in use.

ACARS Data .... Set

PREFLIGHT page:

INIT DATA page:

Verify that the flight number is correct.

Verify that the origin and destination airport are correct.

Enter the ETD.

Enter the flight time.

Enter Fuel Onboard page 2/2.

Enter the Captain and First Officer identification number Page on 2/2.

When loadsheet is available:

OPT ....Set (C, F/O)

Each pilot must calculate the performance data on their own EFB.

Refer to EFB's manual for OPT calculations.

Performance Data ....Set (C, F/O)

Set all data according to OPT values.

PERF INIT page:

Enter the ZFW.

Verify that the FUEL on the CDU, the dispatch papers, and the fuel quantity indicators agree. Do not insert total fuel manually on the CDU. Verify that the fuel is sufficient for flight.

Verify that the gross weight on the CDU and the dispatch papers agree.

Thrust Mode Display - Verify which mode is shown:

TO / D-TO / TO 1 / D-TO1 on 800SFP and SFP 2.0;

TO / RTO for other models;

Dashes are shown (if FMC not computing N1).

N1 LIMIT page:

OAT must be manually inserted;

Verify correct engine rating matching the takeoff analysis;

Select an assumed temperature, if the case;

Use the automatic selection or manually select the Climb Thrust to comply with the policy regarding its use.

Note:confirm correct engine rating (___K).

TAKEOFF REF page 1:

Enter the takeoff flaps;

Enter the CG;

Verify that a trim value is shown;

Enter the takeoff speeds.

TAKEOFF REF page 2:

Verify or enter the Acceleration Height as indicated on the takeoff analysis; minimum value 400 ft;

Verify or enter the Engine Out Acceleration Height as indicated on the takeoff analysis; minimum value 400 ft;

Verify or enter a Thrust Reduction Altitude (as installed).

Note: FMC does not accept thrust reduction values below 800 ft. Pilot Monitoring must reduce manually to N1 climb thrust.

Note: if an acceleration height higher than that shown on the takeoff analysis is to be used, the engine out acceleration height has to match the one shown on the takeoff analysis.

Check the takeoff analysis.

Note: both pilots must check the performance data in their own EFB.

Verify that the CDU Preflight is complete.

N1 bugs - Verify that the N1 with reference bugs are correct.

IAS bugs - Verify that the V Speeds are set.

AUTOTHROTTLE ARM switch - ARM

IAS/MACH selector - Set V2

Arm LNAV as needed.

Arm VNAV as needed.

Takeoff Briefing

OPT BRIEFING .... Complete (C, F/O)

Pilot Flying	Pilot Monitoring
When all OPT fields are completed	
OPT compare calculation..............Select	"No mismatches found"................CALL
All performance data must match between OPTs and message "No mismatches found" is shown.	
OPT Briefing	
Request......................"OPT BRIEFING"	
All takeoff dispatch fields must be checked and briefed.	

Note: OPT briefing may be performed independently of departure briefing.

In case of any changes (e.g. LMC) after OPT briefing is done, both pilots must perform the OPT filling and briefing again.

DEPARTURE BRIEFING .... Complete (C, F/O)

Perform the takeoff briefing according to FCTM.

Each pilot should brief their own actions.

Pilot Flying is responsible to perform the takeoff briefing.

Pilot flying must brief based on the inserted values on FMC.

Pilot monitoring confirms correct data through original publications as directed:

Pilot Flying	Pilot Monitoring
FMC: RTE - Origin, Destination, Company Route, ATC route cleared;	Flight Planning;
INIT REF - GW, FUEL, ZFW;	OPT or other source;
N1 - Thrust Rating, ATM, CLB rating policy;	OPT or other source;
TAKEOFF DATA - Flaps, CG, Stab Trim, V-Speeds, Acceleration Altitude;	OPT or other source;
FMC Legs Page.	SID fixes and restrictions on chart.

Note: when RTO briefing is performed each crewmember should emphasize their own action loud and clear for better CRM.

In case of any changes after takeoff briefing is done, pilot flying may address only information that changed. There is no need to perform the complete takeoff briefing again.

CDU and EFB display .... Set (C, F/O)

The PF selects the TAKEOFF REF page on CDU.

The PM selects the LEGS page on CDU

Both pilots select aerodrome chart on EFB for pushback and taxi.

Do the remaining steps after refueling is complete if external power is in use and APU is available:

APU .... START then ON (F/O)

When APU GEN OFF BUS light is illuminated:

APU GENERATOR bus switches - ON

Verify that the SOURCE OFF lights are extinguished.

Verify that the TRANSFER BUS OFF lights are extinguished.

Verify that the STANDBY PWR OFF light is extinguished.

APU BLEED air switch - ON

Proceed on the remaining steps when the clearance to close the doors is given to the flight attendants:

Parking Brake .... Set (C)

Note: parking brake should be applied before closing doors so ACARS can record parking brake release time.

Fuel Panel .... Set (F/O)

AFT and FORWARD FUEL PUMP switches .... ON

Verify that the LOW PRESSURE lights are extinguished.

If the center tank fuel quantity exceeds 460 kilograms:

LEFT and RIGHT CENTER FUEL PUMP switches.......... ON

Verify that LOW PRESSURE lights illuminate momentarily and then extinguish.

If the center tank fuel quantity is less than 1.000 kilograms, turn off both center tank fuel pumps switches.

HYDRAULIC PANEL .... Set (F/O)

Electric HYDRAULIC PUMP switches - ON

Verify that the electric pump LOW PRESSURE lights are extinguished.

Verify that the brake accumulator pressure is 2.800 psi minimum.

FLT DECK DOOR .... Closed and locked (F/O)

Verify that the LOCK FAIL light is extinguished.

Trim .... Set (C)

Check each trim for freedom of movement.

Stabilizer trim - ___Units

Set the trim for takeoff.

Verify that the trim is in the green band.

Aileron trim - 0 units

Rudder trim - 0 units

FLIGHT DECK WINDOWS .... Closed and locked (C, F/O)

Before Start Checklist for B737-___/___K

The captain identifies the aircraft type and engine thrust for takeoff. The checklist is to be done after the flight deck door is locked.

(C): Request "Before start checklist B737-___/___K"

(F/O): Do (read aloud) the requested checklist.

FLIGHT DECK DOOR	CLOSED AND LOCKED	(F/O)
FUEL	_____ KG , PUMPS ON	(BOTH)
DOORS / WINDOWS	LOCKED	(BOTH)
MCP	V2 ___, HEADING ___, ALTITUDE___	(BOTH)
AUTOBRAKE	RTO	(F/O)
TAKEOFF SPEEDS	V1 ___, VR ___, V2 ___	(C)
CDU PREFLIGHT	COMPLETED	(C)
PARKING BRAKE	SET	(C)
RUDDER AND AILERON TRIM	FREE AND 0	(C)
TAXI AND TAKEOFF BRIEFING	COMPLETED	(BOTH)
--		
FASTEN BELTS SWITCH	ON	(F/O)
ANTICOLLISION LIGHT	ON	(F/O)
PARKING BRAKE	AS REQUIRED	(C)

(F/O): Inform "Before start checklist completed to the line"

Start Clearance

ATC clearance for pushback and engine start should be obtained after the reading of the Before Start Checklist and all external doors are verified closed.

Note: parking brake must be released prior to start the aircraft movement.

Call "Before Start Below the Line" .... (C)

After assuring that the safety area is clear.

FASTEN BELTS switch ....ON (F/O)

ANTI COLLISION light switch ....ON (F/O)

Transponder ....As needed (F/O)

At airports where ground tracking is not available, select STBY. At airports equipped to track airplanes on the ground, select an active transponder (except a TCAS mode).

Before Start Checklist (When Clear For Start)

(C): request "Before start checklist below the line"

(F/O): Do (read aloud) the requested check list

....		
FASTEN BELTS SWITCH	ON	(F/O)
ANTICOLLISION LIGHT	ON	(F/O)
PARKING BRAKE	AS REQUIRED	(C)

Note: if pushback is not required or LPU (Low Pressure Unit) will be used, the parking brake MUST remain APPLIED after reading the check list.

(F/O): Inform "Before Start Checklist completed"

(C): Inform to maintenance: "Cleared for pushback, parking brake released"

Pushback or Towing Procedures

Engine Start procedure may be performed during the push back or towing procedure.

Note: if a crossbleed start is required, do not execute this procedure during the push back or towing.

All communication with ground personnel will be handled by the captain. Standard phraseology should be used. If needed, conventional hand sign may be used.

The ground personnel should be informed of any delay regarding to the push back / engine start procedure.

Ground personnel will be responsible for external safety during the push back. The pilots will monitor such procedure.

The captain must maintain positive contact with the brake pedals during the push back procedures.

Perform the flight controls check after releasing ground personnel. It is not necessary to wait for them to move away from the aircraft to start this check.

After disconnecting the headset, ground personnel must position itself on the left side the aircraft (right side if there is agreement with the captain) in order to show the gear pin and clear for taxi sign.

CAUTION: do not hold or turn the nose wheel steering wheel during PUSH BACK or towing. This can damage the nose gear or the tow bar.

CAUTION: do not use airplane brakes to stop the airplane during PUSH BACK or towing. This action can damage the nose gear or the tow bar.

The captain sets or releases the parking brake as directed by ground personnel.

CAUTION: visually check the aircraft is stopped before applying parking brake.

PUSH BACK Procedures with the nose gear steering lockout pin **NOT installed**:

Note: nose gear steering lockout pin is normally installed. **This procedure is normally NOT performed.**

System “A” HYDRAULIC PUMP switches .... OFF

Verify that the system A pump LOW PRESSURE lights are illuminated.

Note: system “A” HYDRAULIC PUMP switches are switched ON only after the ground personnel is released, after the push back is complete, checking LOW PRESSURE lights OFF.

Engine Start Considerations

Normal starter duty cycle:

-700 and -800 Fleets Only

- Multiple consecutive start attempts are permitted. Each start attempt has a limit of 2 minutes of starter usage.

-MAX 8 Fleet Only

- Multiple consecutive start attempts are permitted. Each start attempt has a limit of 3 minutes of starter usage.

- A minimum of 10 seconds is needed between start attempts.

Extended engine motorings:

-700 and -800 Fleets Only

- Starter usage is limited to 15 minutes for the first two extended engine motorings. A minimum of 2 minutes is needed between each attempt.

-700 and -800 Fleets Only

- For the third and subsequent extended engine motorings, starter usage is limited to 5 minutes. A minimum of 10 minutes is needed between each attempt.

-MAX8 Fleet Only

- Starter usage is limited to 5 minutes for all extended engine motorings. A minimum of 5 minutes is needed between the first two extended engine motorings.

MAX8 Fleet Only

- For the third and subsequent extended engine motorings, a minimum of 10 minutes is needed between each engine motoring.

Normal engine start considerations:

- Do not move an engine start lever to IDLE early or a hot start can occur;
- Keep a hand on the engine start lever while monitoring RPM, EGT and FUEL FLOW, until stable;
- If fuel is shut off accidentally (by closing the engine start lever) do not reopen the engine start lever in an attempt to restart the engine;

- Failure of the ENGINE START switch to stay in GRD until the starter cutout can cause a hot start. Do not re-engage the ENGINE START SWITCH until engine RPM is below 20% N2;
- If a fluid leak (other than a continuous stream) from any of the engine drains is discovered during Exterior Inspection, the engine can be started. Do not perform Single Engine Taxi Out procedures in this case. If during engine start the ground crew reports a fluid leak from an engine drain, the engine start may be continued.

-700 and -800 Fleets Only

- With the engine at idle thrust, accelerate to 35% of N1 for 40 seconds. Than return to idle thrust.

- In either case, run the engine at the idle thrust for up to 5 minutes.
- If the fluid leak stops during this time, no maintenance action is needed.
- If the fluid leak continues after 5 minutes, shutdown the engine for maintenance action.

-700 and -800 Fleets Only

- If the leak does not exceed 90 drops per minute, the aircraft can be dispatched with no further action;

- For the first flight of the day, at airport elevations at or above 2.000 feet MSL, if the temperature is below 5ºC / 41ºF, consider placing the Ignition select switch in BOTH before starting the engines. This may increase the likelihood of a successful engine start on the first attempt.

Do the ABORTED ENGINE START checklist if one or more of the following abort start conditions occur:

- The N1 or N2 does not increase or increases very slowly after the EGT increases;
- There is no oil pressure indications by the time that the engine is stable at IDLE;
- The EGT does not increase by 15 seconds after the engine start lever is moved to IDLE;
- The EGT quickly nears or exceeds the start limit.

Engine Start Procedure

Verify that the secondary engine indications are shown ....(C, F/O)

Start sequence ....Announce (C)

Obtain the clearance with ground personnel to start the engines.

Call "Start Eng. No.___"

Air conditioning PACK switches .... OFF (F/O)

APU BLEED air switch ....ON (F/O)

ENGINE START switch .... GRD (F/O)

Start chronometer ....(C)

Monitor time of starter duty cycle.

Verify that the N2 RPM increases ....(C, F/O)

When N1 rotation is seen and N2 is at 25%, or (if 25% is not possible), at maximum motoring and a minimum of 20% N2:

Note: maximum motoring occurs when N2 acceleration is less than 1% in approximately 5 seconds.

MAX8 Fleet Only

Only open the start lever after the MOTORING indication on the N2 indicator blanks.

Engine start lever .... Idle (F/O)

Keep the hand on the start lever until the engine is at stable idle.

MAX8 Fleet Only

Note: during the TCMA/EOS test, fuel flow indication will be zero and the ENG VALVE CLOSED light will illuminate blue until the test is complete.

Start chronometer .... (F/O)

Monitor time to EGT rise.

Monitor fuel flow and EGT indications .... (C, F/O)

-700 and -800 Fleets Only

At 56% N2, verify that the ENGINE START switch moves to OFF. If not, move the ENGINE START switch to OFF manually.

MAX8 Fleet Only

At 63% N2, verify that the ENGINE START switch moves to OFF. If not, move the ENGINE START switch to OFF manually.

Verify that the START VALVE OPEN alert extinguishes when the ENGINE START switch is in the OFF position.

Callout any abnormal indications.

Call "STARTER CUTOUT."..(F/O)

Monitor N1, N2, EGT, fuel flow and oil pressure for normal indications while the engine accelerates to stable idle...........(C, F/O)

Note: Single Engine Taxi Out procedures should be performed whenever possible. If this is not the case, start the other engine before taxi is commenced.

Before Taxi Procedures

Threats and errors associated with this phase of flight are:

- *Aircraft flap configuration;*
- *Wrong taxiways and ramp exits;*
- *Abrupt steering inputs;*
- *Use of prohibited PED's;*
- *Idle chat;*
- *Airport works in progress;*

These items are not limited to and pilots are expected to anticipate any threat.

Single Engine Taxi Out procedures should be performed whenever possible, on dry or wet surfaces.

This procedure should not be performed on the following conditions:

- slippery aprons and taxiways.
- first flight of the day of the aircraft, or after it has been shut down for more than 3 hours.

If any of the above situations apply, start the other engine before taxi.

Flap extension for takeoff:

Call **"Set Takeoff Flaps ___"** .... (C)

Call for the extension any time after the pushback is complete.

Flap lever .... Set takeoff flaps (F/O)

Set flap lever on captain's command.

Verify that the LE FLAPS EXT green light is illuminated.

Perform the following procedures after the first engine start is complete:

GENERATOR switch (operating engine) ....ON (F/O)

PACK switches ....AUTO (F/O)

ISOLATION VALVE switch ....____ (F/O)

ENGINE BLEED air switches ....____ (F/O)

APU BLEED air switch ....____ (F/O)

Flight controls ....Check (C)

Perform the flight controls check after releasing ground personnel. It is not necessary to wait for the maintenance to move away from the aircraft to start this check.

Make slow and deliberate inputs, one direction at a time.

Move the control wheel and control column to full travel in both directions and verify:

- Freedom of movement;
- That the controls return to center

Hold the nose wheel steering wheel during the rudder check to prevent nose wheel movement.

Move the rudder pedals to full travel in both directions and verify:

- Freedom of movement;
- That the rudder pedals return to center.

(C): Call "Single Engine Before Taxi Checklist"

(F/O): Do (read aloud) the requested checklist.

SINGLE ENGINE BEFORE TAXI		
GENERATOR (Operating Engine only)	ON	(F/O)
PACKS	AUTO	(F/O)
ISOLATION VALVE	________	(F/O)
FLIGHT CONTROLS	CHECKED	(C)
GROUND EQUIPMENT	CLEAR	(BOTH)

Single Engine with:	PACKS	Isolation Valve	Engine Bleeds	APU Bleed
APU and ENG No.2	AUTO	CLOSED	ON	ON
APU and ENG No.1	AUTO	OPEN	OFF	ON
APU OFF (Any Eng)	AUTO	CLOSED	ON	OFF

(F/O): Inform "Single Engine Before Taxi Checklist completed"

CAUTION: Use of high thrust may be required to start taxiing. Be aware of jet blast hazard.

If both engines have to be started before taxi:

After the "Starter Cutout" for the first engine, call for the start of the other engine .... (C)

ISOLATION VALVE switch .... Closed (F/O)

Perform this item only if Engine No.2 was started first.

Right PACK switch .... AUTO (F/O)

Perform this item only if Engine No.2 was started first.

The engine start steps starting from the call for the engine start will be repeated for the other engine.

Flap extension for takeoff:

Call **"Set Takeoff Flaps ___"** C

Call for the extension any time after the pushback is complete.

Flap lever .... Set takeoff flaps (F/O)

Set flap lever on captain's command.

Verify that the LE FLAPS EXT green light is illuminated.

After the Engines are running at stable idle.

GENERATOR 1 and 2 switches .... ON (F/O)

WING ANTI-ICE switch .... As needed (F/O)

ENGINE ANTI-ICE switches .... As needed (F/O)

PACK switches .... AUTO (F/O)

ISOLATION VALVE switch .... AUTO (F/O)

ENGINE BLEED air switches .... ON (F/O)

APU BLEED air switch .... OFF (F/O)

APU switch .... OFF (F/O)

ENGINE START switches .... CONT (F/O)

MFD - SYS .... Push ENG (F/O)

Blank the display of the secondary engine indications.

Flight Controls .... Check (C)

Before Taxi Checklist (Dual Engine)

(C): Request “Dual Engine Before Taxi Checklist”

(F/O): Do (read aloud) the requested checklist

DUAL ENGINE BEFORE TAXI		
GENERATORS	ON	(F/O)
ANTI-ICE		(F/O)
APU		(F/O)
ENGINE START SWITCHES	CONT	(F/O)
RECALL	CHECKED	(BOTH)
ENGINE START LEVERS	IDLE	(C)
FLIGHT CONTROLS	CHECKED	(C)
GROUND EQUIPMENT	CLEAR	(BOTH)

(F/O): Inform “Before Taxi Checklist completed”

Lower Display Unit or Secondary Engine Indications

The Lower Display Unit or Secondary Engine Indications are to be blanked by the first officer after both engines are running and both pilots check that all respective indications are in the normal range.

Any exceedance will pop up during the flight.

-700 and -800 Fleets Only

The lower DU should remain blanked but fully visible at all times. Its brightness setting should be the same for that used on the other DU’s.

Taxi Notes:

- The captain will call for the TAXI Light ON or OFF with the aircraft either stopped or taxiing.
- Landing Lights and Runway Turnoff lights may be used if improved visibility is desired.

Taxi Speed Limits:

Normal taxi speed is approximately 20 knots, adjusted for conditions. On long straight taxi route speed up to 30 knots is acceptable, however, at speeds higher than 20 knots use caution when using the nose wheel steering wheel to avoid over controlling the nose wheels. When approaching a turn, speed should be slowed down.

DRY - Straight taxi / Wide turns / Turns (90º or less) **......30/15/10kt**

WET - Straight taxi / Wide turns / Turns (90º or less) **.....20/10/07kt**

Before Takeoff Procedures

Captain	First Officer
Just before taxi is initiated: a) Crosscheck Flap indicated in CDU and Flap Position Indicator; b) Crosscheck thrust indicated in the takeoff data (OPT), CDU and THRUST MODE DISPLAY.	If fuel quantity is below 1000 kilograms, BOTH center tank fuel pump switches must be OFF for taxi. **Note:** during taxi if any center tank LOW PRESSURE light becomes illuminated, BOTH center tank fuel pumps must be positioned in OFF.
The PF updates changes to the takeoff briefing as needed.	

Before Takeoff Checklist

(C): Request "Before Takeoff Checklist"

(F/O): Do (read aloud) the requested checklist

BEFORE TAKEOFF CHECKLIST
FLAPS... ____/GREEN LIGHT (C)
STABILIZER TRIM...____UNITS (C)

(F/O): Inform "Before Takeoff Checklist completed to the line (single engine) or completed (dual engine)"

If Single Engine Taxi Out is being performed:

When it is predicted to comply with engine warm up recommendations before takeoff, start the second engine considering normal starter duty cycle and abort start conditions.

Either an APU assisted or crossbleed engine start may be performed. This should only be done with the aircraft either stopped or taxiing on straight taxiways.

CAUTION: if an abort start condition occurs, the aircraft must be immediately parked.

Call "Start Engine No.__" .... (C)

Left PACK switch or both PACK switches........................ OFF (F/O)

ENGINE START switch (engine being started) .... GRD (F/O)

Start chronometer .... (C)

Monitor time of starter duty cycle.

Verify that the N2 RPM increases ....(F/O)

When N1 rotation is seen and N2 is at 25%, or (if 25% is not possible), at maximum motoring and a minimum of 20% N2.

Note: maximum motoring occurs when N2 acceleration is less than 1% in approximately 5 seconds.

MAX8 Fleet Only

Only open the start lever after the MOTORING indication on the N2 indicator blanks.

Engine Start lever... IDLE (F/O)

Keep the hand on the start lever until the engine is at stable idle.

MAX8 Fleet Only

Note: during the TCMA/EOS test, fuel flow indication will be zero and the ENG VALVE CLOSED light will illuminate blue until the test is complete.

Start chronometer .... (F/O)

Monitor time to EGT rise.

Monitor fuel flow and EGT indications .... (F/O)

-700 and -800 Fleets Only
At 56% N2, verify that the ENGINE START switch moves to OFF. If not, move the ENGINE START switch to OFF manually.

MAX8 Fleet Only
At 63% N2, verify that the ENGINE START switch moves to OFF. If not, move the ENGINE START switch to OFF manually.

Callout any abnormal indications.

Call “Starter Cutout”.. (F/O)

Monitor N1, N2, EGT, fuel flow and oil pressure for normal indications while the engine accelerates to stable idle ....(C, F/O)

When both engines are running at stable idle:

GENERATOR 1 or 2 switch .... ON (F/O)

WING ANTI-ICE switch .... As needed (F/O)

ENGINE ANTI-ICE switches .... As needed (F/O)

PACK switches .... AUTO (F/O)

ISOLATION VALVE switch .... AUTO (F/O)

ENGINE BLEED air switches .... ON (F/O)

APU BLEED air switch .... OFF (F/O)

APU switch .... OFF (F/O)

ENGINE START switches .... CONT (F/O)

Recall .... Check (C, F/O)

Verify that all system annunciator panel lights illuminate and than extinguish.

MFD - SYS ....Push ENG (F/O)

Blank the lower display unit.

Engine start levers ....IDLE detent (F/O)

(C): Call “Before Takeoff Checklist below the line”

(F/O): Do (read aloud) the requested checklist

FOR SINGLE ENGINE TAXI OUT AFTER BOTH ENGINES ARE RUNNING
GENERATORS.. ON (F/O)
ANTI ICE.. ___ (F/O)
APU.. (F/O)
ENG START SWITCHES..CONT (F/O)
RECALL.. CHECKED (BOTH)
ENGINE START LEVERS..IDLE (C)

(F/O): Inform "Before Takeoff Checklist completed"

Engine warm up requirements:

Verify an increase in engine oil temperature before takeoff.

MAX8 Fleet Only

Run the engines for at least 3 minutes before takeoff when grounded for less than 5 hours.
Run the engines for at least 5 minutes before takeoff when grounded for more than 5 hours

Engine warm up recommendations:

-700 and -800 Fleets Only

Run the engines for at least 2 minutes before takeoff.

Use a thrust setting normally used for taxiing operations.

Note:do not use the thrust reversers during taxi operations.

Runway Change Checklist

To be performed in case of runway change during taxi out.

RUNWAY CHANGE		
FLAPS	___GREEN LIGHT	(C)
N1	___K, FULL/REDUCED	(C)
IAS BUGS	V1___,VR___, V2___	(C)
STABLIZER TRIM	___UNITS	(C)
TAKEOFF BRIEFING	COMPLETED	(BOTH)
CDU SID UPDATE	COMPLETED	(F/O)

Before Takeoff Procedures

Captain	First Officer
WHEN CLEARED TO ENTER THE TAKEOFF RUNWAY	
After cabin is secured for take-off: Weather Radar* or TERR on ND	Strobe Lights: ON Wing Lights (night flight): ON Transponder: TA/RA Weather Radar* or TERR on ND

*Weather radar may be off in daytime VMC flights.

Takeoff Notes

Limits:

Minimum altitude to initiate any turn is 200 ft AFE.

Minimum acceleration altitude is 400 ft AFE.

General Notes

During a Flap 1 takeoff the clearance between the fuselage and the ground is minimum during rotation. Strictly observe FCTM recommendations.

Before entering the departure runway, verify that the runway and runway entry point are correct.

Takeoff must be performed using the entire runway. If not, specific takeoff analysis must be used.

To align up at the runway threshold avoid tight turns in order to prevent unnecessary load on tires and gear and damage to the pavement.

If the pilot flying will be the first officer, the transfer of the controls must be made in an assertive way. The captain calls “You have controls”, and the first officer calls “I have controls”.

The captain must be ready to take control over the steering wheel, if needed, until approximately 30kt. Release any control inputs after aligned with the runway, using the steering wheel only if needed in an abnormal situation.

Use caution when using the nose wheel steering above 20kt to avoid over controlling the nose wheels resulting in possible loss of directional control.

To start the takeoff, the captain advances the thrust levers to approximately 40% N1, allow the engines stabilize and push the TO/GA switch with the aircraft aligned with the runway.

Takeoff

Threats and errors associated with this phase of flight are:

- *Under rotation;*
- *Improperly trimmed stabilizer;*
- *Tail strike pitch attitude (degrees): B700 14,7°, B800 and MAX8 11,0°*

These items are not limited to and pilots are expected to anticipate any threat.

Pilot Flying	Pilot Monitoring
FMC: Takeoff page EFB recommended page: SID chart	FMC: Legs page EFB recommended page: Contingency Chart when available or SID chart when not.
When Lining Up for Takeoff	
The captain calls: “Takeoff Rwy___(L or R) HDG ____º”. First Officer confirms: “HDG ____°” HDG Bug: Runway Heading Crosscheck that the airplane heading agrees with the assigned runway heading.	
When Cleared for Takeoff	
F/O: Fixed Landing Lights: ON Both Pilots: Clock / Chronometer: Run	
If the F/O will be the PF the captain calls: “You have controls”, and the F/O confirms “I have controls”.	
The captain advances the thrust levers to approximately 40% N1, allow the engines to stabilize and pushes the TO/GA switch with the aircraft aligned with the runway.	
	Callout all boxed FMA modes as TO/GA is pushed. Monitor the engine instruments during the takeoff. Call out any abnormal indications. Adjust takeoff thrust before 60 knots as needed.

Pilot Flying	Pilot Monitoring
	During strong headwinds, if the thrust levers do not advance to the planned takeoff thrust, manually advance the thrust levers before 60 knots.
Request “Check Thrust”.	Verify that the correct takeoff thrust is set. Call: “Thrust Set”.
The captain's hand must be on the thrust levers until the V1 callout.	
Monitor airspeed. Maintain light forward pressure on the control column.	Monitor airspeed and call out any abnormal indications.
Verify 80 Knots and call “CHECK”	Verify 80 knots and call “80 KNOTS” Verify A/T – THR HLD mode and callout “Throttle Hold”
Verify V1 speed	Verify V1 minus 5 knots and call “V1” (this callout must be made even on auto V1 callout equipped aircraft)
At VR, rotate toward 15° pitch attitude. After liftoff, follow F/D commands.	At VR call “ROTATE” Monitor airspeed and vertical speed.
Establish a positive rate of climb.	
	Verify a positive rate of climb on the altimeter. Inform: “POSITIVE RATE”.
Verify a positive rate of climb on the altimeter and call “GEAR UP”.	
	Set the landing Gear Lever to up. Monitor pitch, airspeed and vertical speed. Observe Landing Gear Lights. Inform “GEAR UP” in accordance.
Above 400ft AFE	

Monitor Roll Mode or Request as needed (LNAV or HDG SEL). Autopilot may be selected ON. Set "Autopilot CMD"	Monitor or Select a roll mode as requested. Inform FMA Verify and Inform "Autopilot CMD"
Pilot Flying	**Pilot Monitoring**
Thrust Reduction	
At Thrust Reduction Altitude call "SET CLIMB THRUST".	Set or Monitor Climb Thrust as requested Inform "CLIMB THRUST SET"
Monitor Climb Thrust and VNAV.	Monitor FMA
Above 800 ft AFE, request: "N1" or monitor FMA for automatic climb thrust setting	
Acceleration Altitude	
	Call.................."Acceleration Altitude"
Monitor VNAV acceleration If VNAV was not used: Set or Request - "Set Flaps Up Speed" or as needed	Set speed as requested
Request "FLAPS ___" according to the flaps retraction schedule.	Set the FLAP lever as directed. Monitor flaps and slats retraction. Inform each new flap position.
If VNAV is not in use, select or request VNAV after flaps retraction. If unavailable, set or request "speed 250kt or in accordance with ATC"	
After Flaps are UP	
Call "AFTER TAKEOFF CHECKLIST".	Do the "after takeoff checklist". Inform: "AFTER TAKEOFF CHECKLIST COMPLETED"

Note: when thrust reduction altitude matches acceleration altitude, the callouts may be performed in either sequence.

Close - In Turn Takeoff

Perform this specific procedure only when a turn is to be made after departure, and there is a concern to radius distance limit during this turn.

If a close-in turn takeoff will be made, do not arm VNAV.

Initial heading - set

Set runway heading, unless otherwise directed.

Initial altitude - set.

Pilot Flying	Pilot Monitoring
Above 400 ft	
Request HDG SEL Verify FMA Autopilot may be selected ON Set “Autopilot CMD”	Select the HDG SEL roll mode Inform FMA Verify and Inform “Autopilot CMD”
Thrust Reduction / Acceleration Altitude	
At Thrust Reduction Altitude call “SET CLIMB THRUST”.	Set or Monitor Climb Thrust as requested Inform “CLIMB THRUST SET”
Above 800 ft AFE, request: “N1” or monitor FMA for automatic climb thrust setting	Select N1 or Inform FMA.
When approximately 30° to the desired heading	
Request or select: VNAV or “Set flaps up speed”	Speed Bug to desired Speed
Request Flap retraction on schedule.	Position flap as directed. Monitor Flap/Slat retraction. Inform each new position. After flap retraction is complete verify engine bleeds and air conditioning packs are operating
After Flaps are UP	

Call "AFTER TAKEOFF CHECKLIST". If VNAV is not in use, set or request VNAV, or "Set speed 250kt", or in accordance with ATC	Do the "after takeoff checklist". Inform: "AFTER TAKEOFF CHECKLIST COMPLETED"

Takeoff Flap Retraction Speed Schedule

TAKEOFF FLAPS	AT SPEED (display)	SELECT FLAP
25	V2+15 "15" "5" "1"	15 5 1 UP
15 or 10	V2+15 "5" "1"	5 1 UP
5	V2+15 "1"	1 UP
1	"1"	UP
LIMIT BANK ANGLE TO 15° UNTIL REACHING V2+15		

ATC Communication

Whenever possible, communication with ATC after takeoff should be made as soon as the flaps retraction has begun.

Conditional Turn After Departure

If a conditional turn which is not a "close in turn" will be made after departure (for example: maintain runway heading until passing 6000ft), proceed using either of the options:

- Do not arm VNAV for takeoff. Maintain flaps up speed until passing this altitude, then select VNAV.
- Arm the VNAV, and use the Speed Intervention feature to set flaps up speed until passing the conditional altitude.
- Arm the VNAV and set the flaps up speed as a restriction on the CLB page of the FMC until above the conditional altitude.

After Takeoff Procedure

The After-Take off phase is one of the last opportunities to properly configure Air Conditioning and Pressurization System. Do the after takeoff checklist meticulously.

Threat and errors associated with this phase of flight are:

- *Terrain;*
- *Weather;*
- *Traffic;*
- *Pressurization System switches;*

These items are not limited to and pilots are expected to anticipate any threat.

<table>
<tr><th>Pilot Flying</th><th>Pilot Monitoring</th></tr>
<tr><td colspan="2">After the Flaps are UP</td></tr>
<tr><td rowspan="9">Call “After Take Off checklist”

All items of the after takeoff checklist must be verified by the PF.</td><td>ENGINE BLEEDS – ON</td></tr>
<tr><td>PACKS - AUTO</td></tr>
<tr><td>ISOLATION VALVE – AUTO</td></tr>
<tr><td>APU – OFF</td></tr>
<tr><td>Engine Start Switches – As required
In accordance with the PF</td></tr>
<tr><td>Landing gear – Up & Off</td></tr>
<tr><td>Auto Brake – OFF</td></tr>
<tr><td>Flaps – Up No Lights

-MAX 8 EB1 fleet
RUNWAY INHIBIT - INHIBIT</td></tr>
<tr><td>Do (read aloud) the requested checklist and inform “After takeoff checklist completed”.</td></tr>
<tr><td>-700 and -800 Fleets Only
If there is no altitude restriction call:
“Set Full Rated Climb Thrust”</td><td>“Climb Thrust Set”</td></tr>
<tr><td colspan="2">Fasten belts switch - as needed (ON or AUTO)</td></tr>
</table>

After Takeoff Checklist

AFTER TAKEOFF	
ENGINE BLEEDS	ON (PM)
ISOLATION	AUTO (PM)
PACKS	AUTO (PM)
LANDING GEAR	UP and OFF (PM)
FLAPS	UP, NO LIGHTS (PM)

Note: FMC pages for climb PF: CLIMB / PM: LEGS.

Note: for Unpressurized Takeoff or No Engine Bleeds Takeoff refer to Supplementary Procedures.

Climb and Cruise Procedure

Threat and errors associated with this phase of flight are:

- *Disregarding sterile cockpit phase;*
- *ATC communication;*
- *Overspeed;*
- *Adverse Weather*
- *Lack of pilot communication;*
- *Not verbalizing FMA and MCP changes;*
- *Lack of pilot's dual check prior to FMC changes;*
- *High bank angle;*
- *High rate of climb near of level off altitude restrictions;*

These items are not limited to and pilots are expected to anticipate any threat

Pilot Flying	Pilot Monitoring
MSA	
Acknowledge callout	**Inform:** "MSA" Select weather instead of Terrain. Weather radar may be off in daytime VMC.
Accelerate to climb speed according to company policy.	
FL100 or 10.000 FT	

Acknowledge 10.000ft	Inform: "10.000ft" Fixed Landing Lights / Wing Lights: OFF Pressurization: Check normal operation Supply duct temperature: Check in adequate range
	Center Tank Fuel Pump must be ON if any quantity of remaining fuel exists. Position the appropriate Center Tank Fuel Pump Switch OFF when the LOW PRESSURE light illuminates or tank is empty. On an ETOPS flight, check the ETOPS Supplementary Procedure in SP.1. Normal climb pneumatic duct pressure 34 to 50 PSI.

CAUTION: do not allow the shoulder harness straps to retract quickly. Buckles can pull or damage circuit breakers.

Note: "MSA" callout should be made by PM under any flight conditions.

Cruise Procedures

Pilot Flying	Pilot Monitoring
When reaching cruise altitude	
	LOGO Light (if applicable) OFF
	PRESSURIZATION Check Verify Cabin Altitude Indicator and Cabin Differential Indicator in normal range. Normal cruise pneumatic duct pressure 26 to 50 PSI.
Altimeter "________ FT" Check STD and RVSM limits.	Altimeter "__________FT" Check STD and RVSM limits
	Verify the Thrust Mode Display - CRZ
	FUEL Check Verify Fuel Consumption is in accordance with Navigation Plan. Center Tank Fuel Pump must be ON if any quantity of remaining fuel exists. Position the appropriate Center Tank Fuel Pump Switch OFF when the LOW PRESSURE light illuminates or tank is empty.

	GMORA Check Verify on Navigation Plan and Inform the PF all GMORA above 10.000 ft.
FMS: LEGS	**FMS: PROGRESS**
Trim the aircraft using the Primary Rudder Trim Technique, if needed	
	After the first hour of flight, the fuel temperature must be checked every hour in order to avoid fuel freezing. If the fuel used is Jet A1 or Jet A and the temperature reaches -40° C, request a lower flight level. If the fuel used is not Jet A1, request the fuel freeze temperature to the maintenance before flight. During the last hour of cruise on all ETOPS flights, do a Fuel Crossfeed Valve check. Before the top of descent, modify the active route as needed for the arrival and approach.

Descent Procedures

Threat and errors associated with this phase of flight are:

- *Rhyming briefing;*
- *Not verbalizing FMA and MCP changes;*
- *Lack of pilot's dual check prior to FMC changes;*
- *Interruption and distraction;*
- *Overspeed;*
- *STAR / Runway change;*
- *Terrain;*
- *Adverse Weather;*
- *Traffic;*
- *High rate of descent near of level off altitude restrictions;*

These items are not limited to and pilots are expected to anticipate any threat.

Landing Data Limitations and Weather

Landing data regarding to performance limitations and weather info should be written.

STAR

When inserting STAR, check waypoints with altitude restrictions.

ROUTE 2 (if installed): pilots may enter approach contingency when published, when unavailable, pilots may enter route to a runway other than the active runway in use or enter route to the alternate airport located in the operational flight plan.

FMS - Descent Forecast

Descent Forecast page should be filled with data in order to provide information to the FMS accurately calculate the descent path.

OPT Landing procedures

Each pilot must calculate the performance data on their own EFB and compare values with the other crew member before inserting values into FMC.

Refer to EFB’s manual for OPT calculations.

Pilot Flying	Pilot Monitoring
When both OPT fields are completed	
OPT compare calculation (if available)....................................Select	“No mismatches found”.............CALL
All performance data must match between OPTs and message “No mismatches found” must be shown.	
OPT Briefing	
Request..................."OPT BRIEFING"	

Note: OPT briefing may be performed independently of approach briefing.

Approach Briefing

Perform the approach briefing according to FCTM.

Each pilot should brief their own actions.

Pilot Flying is responsible to perform the approach briefing.

Pilot Flying must brief based on the inserted values on FMC.

Pilot Monitoring confirms correct data through original publications as directed:

Pilot Flying	Pilot Monitoring
Set the BARO / RADIO minimum for the approach.	
Autobrake..............................SET	OPT or other source;
FMC: LEGS;	STAR fixes and restrictions on chart;
APPROACH REF - LDG WEIGHT, FLAPS, VREF.	OPT or other source.

Speedbrakes

The use of speedbrakes with Flaps extended should be avoided, if possible.
With flaps 15 or greater, the speedbrakes must be retracted.

-700 with winglets

On airplanes with the speedbrakes wing load alleviation system, the speedbrakes will retract to the “50%” position when airspeed exceeds 320 KIAS. If this occurs do not move the speedbrakes lever beyond the “50%” position until airspeed is less than 320 KIAS.

Start the Descent Procedure before the airplane descends below the cruise altitude for arrival at destination.

Pilot Flying	Pilot Monitoring
Before Descent	
	Verify that pressurization is set to landing altitude. Logo Light (if applicable) – ON Recall and review the system annunciator lights. Set the BARO / RADIO minimum for the approach.
* Modification on the present weather condition must be monitored. It may be necessary to change the chosen Landing Configuration. If in doubt, use the most conservative configuration.	
FMC: DESCENT page	FMC: LEGS page
Call: "Descent checklist".	Do (read aloud) the requested checklist. **Inform "Descent Checklist completed"**

Pilot Flying	Pilot Monitoring
During Descent	
	Normal descent pneumatic duct pressure with Wing TAI OFF is 18 to 25 PSI. Center Tank Fuel Pump must be ON if any quantity of remaining fuel exists. Position the appropriate Center Tank Fuel Pump Switch OFF when the LOW PRESSURE light illuminates or tank is empty. Complete this Procedure by 10,000 feet MSL.
FL100 (or FL200 when landing elevation is greater than 5000ft)	
Acknowledge Information.	Inform: "10.000ft" or "20.000ft" Fixed Landing Lights – ON Wing Illumination Lights (on night flights only) – ON If center tank fuel quantity is below 1000 Kilograms BOTH Center Tank Fuel Pump Switches must be OFF. **Note:** if any LOW PRESSURE light becomes illuminated BOTH Center Tank Fuel Pump must be positioned in OFF.

Maintain descent ECON speed according to company policy, airspace, ATC or arrival's speed restrictions.

MSA	
Acknowledge	Inform: "MSA"
	Select TERRAIN on the NAV Display.

WARNING: GPWS – Any alert received below MSA must be considered as real. If not in DAYTIME VMC condition take action immediately.

Descent Checklist

DESCENT	
PRESSURIZATION	LAND ALT ___ ft (PM)
RECALL	CHECKED (PM)
LDG DATA	FLAP_ VREF _ MINS_ (PM)
APROACH BRIEFING	COMPLETED_ (PF)

Approach Procedures

Threat and errors associated with this phase of flight are:

- *Adverse weather (runway and wind condition);*
- *Lack of energy management;*
- *Safety window violations;*
- *Profile shortcuts;*
- *Flap exceedance;*
- *Not verbalizing FMA and MCP changes;*
- *Lack of pilot's dual check prior to FMC changes;*
- *Expectation Bias;*

These items are not limited to and pilots are expected to anticipate any threat.

Pilot Flying	**Pilot Monitoring**
"A" - At Transition Level	
Set Altimeters with QNH and crosscheck____ - hPa;________- FT.	Set Altimeters with QNH and crosscheck ______ - hPa;____________- FT.
Pilot Flying	**Pilot Monitoring**

<table>
<tr><th colspan="2">“B” - When NAV Radios are not in use for navigation</th></tr>
<tr><td colspan="2">If after the approach briefing is done and the NAV radios will not be used during the descent (RNAV Star for example), the “set radios for approach” procedure should be done immediately after the “approach briefing”</td></tr>
<tr><td>Perform Set Radios for Approach procedure:
Confirm conditions for approach:
·Rwy_____; Dry or Wet;
·Landing Flap;
·Autobrake Selection;
· Review Missed Approach Plan:
·Go-around procedure
·Callouts;
·Execution of maneuver.
·Set radios for Approach___

Maintain Expanded MAP Mode.
EFIS Control Panel: VOR/ADF switch in accordance with IAL.
MCP: Course;</td><td>“Set Radios” flow procedure:
EFIS Control Panel: VOR/ADF switch in accordance with IAL.
Center Switch (CTR): Press to select VSD on ND if installed. Otherwise the ND should remain in MAP or CTR-MAP.
NOTE: for raw data approach, select POS.
MCP: Course;
RMI Standby: VOR/ADF bearing pointers in accordance with IAL (according to the area of responsibility)
NAV Radios: select frequencies for Approach
Radios: Identify PFD/ND;
Markers: ON
Inform “Set Radios for Approach is Completed”.
Note: all Steps must be verbalized

* On approach procedures with the initial segment outbound from the radial fix, the MCP Course should be set for the outbound course; 10 seconds prior to the procedure turn, the MCP Course should be set for the final approach course.
Note: exact scan flow for each type of procedure is exposed in APPROACH PATTERN.</td></tr>
<tr><th colspan="2">The approach procedure may have A&B or B&A order</th></tr>
<tr><td colspan="2">The approach Checklist should be performed after both (A&B) have been accomplished.</td></tr>
<tr><td>Request: “APPROACH CHECKLIST”</td><td>Do (read aloud) the requested checklist.
Inform “APPROACH CHECKLIST COMPLETED”</td></tr>
</table>

Approach Checklist

APPROACH	
ALTIMETERS	_____SET and X- CKD (PF)
RWY / AUTOBRAKE	___/___ (PF)
-MAX 8 EB1 fleet RUNWAY INHIBIT	INHIBIT

Note: for item “RWY”, the answer must be “RWY IN USE” and “RWY CONDITION”.

Complete the Approach Procedures before:

- the initial approach fix, or
- the start of radar vectors to the final approach course, or
- the start of a visual approach.

For a GLS approach, select the appropriate GLS channel.

For an ILS, LOC, BCRS, SDF or LDA approach, select the appropriate localizer frequency.

GOL does not perform BCRS approaches.

Flap Extension Schedule

Current flap position and speed	Select flaps and command speed
UP	1
1	5
5	15
15	30 or 40

Note: the PM must callout “Speed check” before moving the flap lever to the new requested position, acknowledging the actual airspeed is below the requested flap placard speed.

Flap is to be extended at or near the actual flap maneuvering speed.

Flap 25 may be used as an intermediate position before selecting Landing Flaps at pilot's discretion. This is specially recommended when the Flaps 15 maneuvering speed is too close to the Leading Flaps Placard Speed.

If a flap 15 landing is needed because of performance:

GROUND PROXIMITY

Flap Inhibit Switch .... FLAP INHIBIT (F/O)

Autoland

Must be performed landing flaps 30 or 40.

Wind information: Obtained from FMC Progress Page 2/4

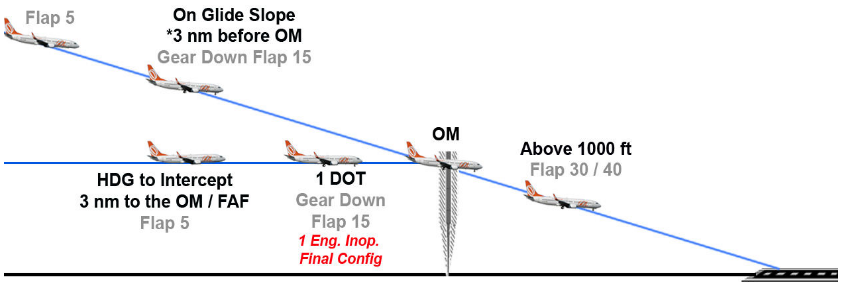
Landing Checklist Notes

- If a runway change occurs after the LANDING CHECKLIST is read, perform the LANDING CHECKLIST once again.
- During Landing Checklist Reading, the Pilot Monitoring should verify the new position pointing out to the instrument and confirming “FLAP 40" or “FLAP 30". This flaps pointing procedure was developed to ensure the planned flap for landing matches with the flap selected.

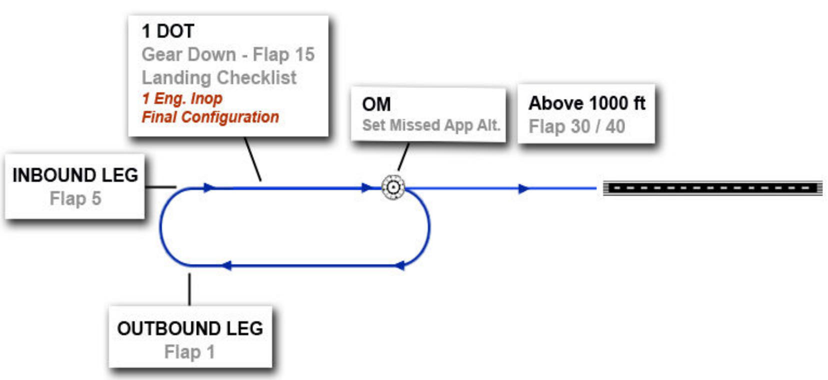
Approach flight patterns

ILS

For approaches through radar vectors or STAR:



* Configure gear down & Flaps 15 when 3nm to OM or 7nm before THR whichever occurs first



- When on localizer intercept heading, verify that the ILS is tuned and identified, and that the LOC and G/S pointers are shown.
- ILS based on RNAV STAR:

  The ILS should be intercepted in LNAV/VNAV when executing a RNAV ILS.

  When a RNAV ILS is not available or when on radar vectors, V/S should be used to intercept the ILS and LVL CHG mode may be used before OM.
- Verify FMA (VOR/LOC and GS);
- For straight in approach, monitor distance to the OM in order not to establish FLAP 05 configuration too early;
- When leveled on the OM crossing altitude, with G/S indicating 1 DOT, select Leading Gear down and Flaps 15 (this will be the final configuration for One Engine Inoperative approach). If G/S inoperative, select Landing Gear down and Flaps 15 at 1nm from OM. If OM inoperative, use associated NDB or DME distance;
- PF: request: “Landing Checklist”. PM: read aloud and do “Landing Checklist”. Visually confirm flap and gear positions;
- Just before 1000ft AFE select Landing Flap;
- At 1000ft AFE aircraft must be in landing configuration;
- The above pattern is indicated for standard operation. Deviations by ATC, heavy or light gross weights, head or tailwinds, must be worked upon;
- During an ILS approach perform a crosscheck between HSI and RDMI, and between G/S and rate of descent;
- It is forbidden to remove ILS frequency during the approach, except for Side Step procedures;
- Glide Slope, VASI and PAPI resources must be used when available;
- When performing an autoland in a ILS Category I the crew must apply ILS Category II requirements and advise ATC. This procedure can be done only under VMC conditions.

WARNING:GPWS or TCAS warnings will have priority over ILS

ILS APPROACHES	
Pilot Flying	**Pilot Monitoring**
Request flaps extension on schedule up to Flaps 5.	Set Flap lever as directed. Fasten Belts Switch – ON: when “Flap 1” is requested
If on radar vectors, the following modes are recommended: • HDG SEL • V/S If enroute to a fix, use: • LNAV or other roll mode • VNAV or other pitch mode Verify that the localizer is captured.	Inform: “LOCALIZER ALIVE” on first inward motion of localizer pointer. FMA: Inform: “LOCALIZER CAPTURED”. Inform: “GLIDE SLOPE ALIVE” on first motion of glide slope pointer;
GS 1 dot or 3NM prior to the OM on the GS request: “Gear Down, Flaps 15, Landing Checklist”. Set SPEEDBRAKE handle in ARM.	Select Gear Down and set flap lever as directed. Observe when Gear Down and green light ON and inform “Gear Down”. Verify SPEEDBRAKE ARMED light illuminated. Do and read aloud - Landing Checklist.
	FMA: Inform: “GS capture”
Set or request Missed Approach Altitude on MCP.	Set Missed Approach Altitude on MCP on request.
Outer Marker	
Confirm OM__________ft- Request: “set MM on ADF 1”	Inform:“OM ________ft” Set MM on ADF 1.
Just before 1000 ft AFE Request: “Flap _____” (Landing Flap)** Set or request VAPP on the MCP.	Set Flap lever as directed
Request: “Complete landing Checklist”.	Do and read aloud the completion of Landing Checklist.
1000FT AFE	
Acknowledge For the ‘NOT STABILIZED GO-AROUND” Callout, confirm “GO-AROUND” and perform missed approach procedure.	Inform: “1000ft, STABILIZED” or “NOT STABILIZED-GO-AROUND”).
500FT AFE	
Acknowledge	Inform: “500 FT - wind: _____”

ILS APPROACHES	
Pilot Flying	**Pilot Monitoring**
100FT above minimum	
Acknowledge	Inform: "approaching minimums".
200FT AFE	
Acknowledge	Inform: "wind: _____"
DA	
Inform: "RWY / APP lights in Sight / Not in sight". "Landing or Go-Around". Night Flight: "All Lights ON".	Inform: "Minimums" Turn the retractable landing lights ON (if installed).
* On approach procedures with the initial segment outbound from the radial fix, the MCP Course must be adjusted for the outbound course; 10 seconds to the procedure turn the MCP Course must be readjusted for the final approach course. The PM must inform any deviation from standard Approach: LOC 1dot deviation; GS 1dot deviation; Flags on instruments; Approach not stabilized on COMPANY limits. ** Flap 25 may be used as an intermediate position before selecting Landing Flaps at pilot's discretion. This is specially recommended when the Flaps 15 maneuvering speed is too close to the Leading Flaps Placard Speed. **Note:** when performing autoland on ILS CAT I, it is mandatory to comply with all ILS CAT II requirements, operational procedures and callouts.	

ILS CAT II (Autoland)	
Pilot Flying	**Pilot Monitoring**
Shortly after the APP MODE has been selected engage the second A/P. Verify that the localizer is captured.	Inform "VOR/LOC and G/S armed".
Outer Marker	
Confirm OM__________ft- Request: "set MM on ADF 1"	Inform: "OM ________ft" Set MM on ADF 1.
Just before 1000 ft AFE Request: "Flap __" (Landing Flap)*. Set VAPP on the MCP.	Set Flap lever as directed
Request: "Complete landing Checklist"	Do and read aloud the completion of Landing Checklist.
1000FT AFE	
Acknowledge For the "NOT STABILIZED GO-AROUND" Callout, confirm "GO-AROUND" and perform missed approach procedure.	Inform "1000 ft" Observe and inform: "STABILIZED" or "NOT STABILIZED-GO-AROUND".
500FT AFE	
Confirm "FLARE ARMED" or; For the "NO FLARE" Callout, advise "GO-AROUND".	Verify on FMA the A/P status and inform: "FLARE ARMED" or "NO FLARE".
100FT above minimum (RA)	
Acknowledge and Inform: "Head up".	Inform: "approaching minimums".
DH	
Inform "LANDING" or "GO-AROUND"; Night Flight: request: "All Lights ON" if proceeding to land.	Inform: "MINIMUMS" Turn the Retractable landing lights – ON (if installed)
50FT (RA)	
Acknowledge and for "NO FLARE" callout, push TO-GA switch and initiate a go-around.	Monitor FMA Inform: "FLARE" or "NO FLARE".
27FT (RA)	
Acknowledge	Monitor FMA Inform: "RETARD"
After Touchdown: DISENGAGE AUTOPILOT	

* "Flap 25" may be used as an intermediate position before selecting Landing Flaps at pilot's discretion. This is specially recommended when the Flaps 15 maneuvering speed is too close to the Landing Flaps Placard Speed.

ILS CAT 2 NOTES

Before starting this procedure the crew must read the ILS CAT II Crew Review at QRH Operator Information chapter.

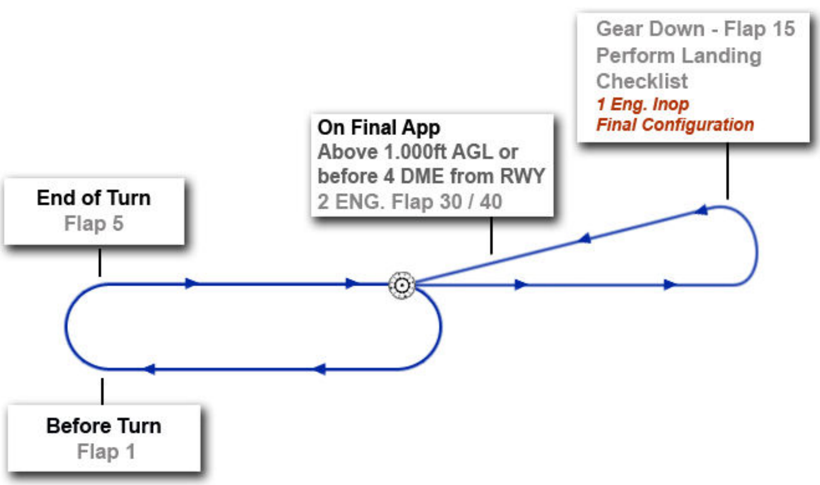
Set “BARO minimums” in accordance with the approach chart to have the bug set in the altimeter, and than set “RADIO minimums”.

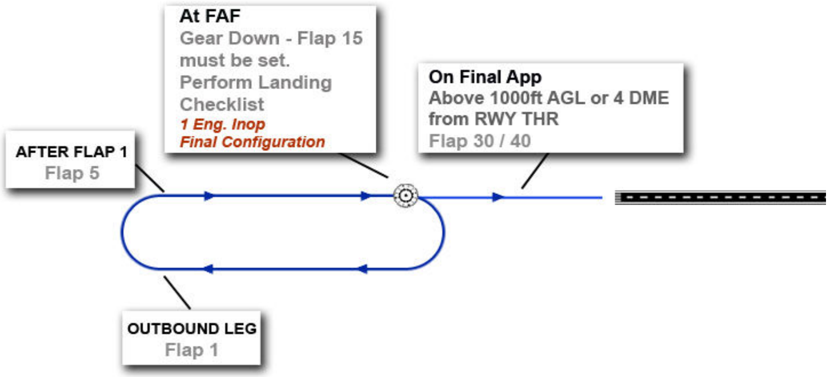
The PM must inform any deviation from standard approach for CAT II:

- LOC ½ dot deviation up to 200ft RA; ⅓ dot deviation below 200ft RA;
- GS ½ dot deviation;
- Flags on instruments;

Note: when performing autoland on ILS CAT I, it is mandatory to comply with all ILS CAT II requirements, operational procedures and callouts.

VOR / NDB / LOC





- Do not use LVL CHG mode after IAF. VNAV should be used or V/S may be used.
- A follow up of the procedure is mandatory to the crew. Altitude must be released step by step and can only be released to the next restriction when compliance is assured, and should occur about 2 NM prior to the next waypoint;
- For an approach through a holding, select Flap 1 at the and of the outbound leg, and select Flap 5 at the end of the turn;
- At the beginning of the final approach or 3 nm prior FAF, the PF requests “Landing Gear Down, Flaps 15 and Landing Checklist”. This will be the final configuration for a One Engine Inoperative approach;
- The PM reads aloud and does the “Landing Checklist”. Visually confirms flap and gear positions;
- After FAF, with runway in sight and when the aircraft is passing 300 ft below the missed approach altitude, set the missed approach altitude on the MCP;
- At 1000ft AFE aircraft must be in landing configuration;
- At MDA disengage Autopilot / Autothrottle in order to land or go-around, as applicable;
- The F/D’s may or may not be reset. Cycling both F/D’s to OFF than to ON eliminates unwanted commands for both pilots and allows F/D guidance in event of go-around;

- Insert the VDP in non-precision approaches if a glide path is not available (FIX page FMC). The VDP defines the point where a missed approach should be initiated: Land or Missed Approach (at MDA height).
- For straight-in approach, monitor distance to the VOR/NDB in order not to establish Flaps 5 or the Gear down and Flaps 15 configuration to early.
- The above pattern is indicated for standard operation. Deviations by ATC, heavy or light gross weights, head or tailwinds, must be worked upon.
- VASI and PAPI resources must be used when available.
- The main method to fly non-precision approaches is using LNAV/VNAV. V/S may be used if there is not a glide path angle shown on the final approach segment of the LEGS page. LNAV method must be accompanied by conventional indication (MAP / CTR MAP plus VOR / LOC / ADF indications). LOCALIZER approaches may be flown using VOR/LOC and VNAV.

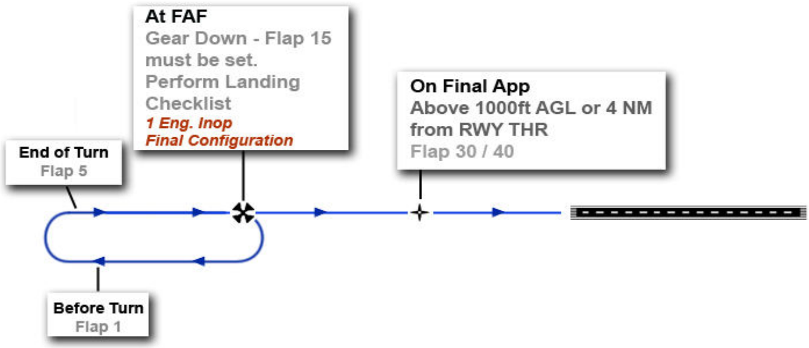
VOR / NDB / LOC only APPROACHES	
Pilot Flying	**Pilot Monitoring**
For approach through a holding, request “Flaps 1" at the end of the outbound leg and set Flaps 1 speed on MCP	Set Flap lever as directed. Fasten Belts Switch – ON: when “Flap 1” is requested.
Request flaps extension on schedule up to Flaps 5. If VNAV is not in use set or request the new flap setting speed to be set on the MCP	Set Flap lever as directed. Monitor extension and inform new flaps configuration when in position and green light ON.
Select LNAV to start lateral navigation and VNAV to start vertical navigation. 10 seconds to the procedure turn the MCP Course must be readjusted for the final approach course.	As applicable: Inform: “COURSE or LOCALIZER ALIVE” on 1st inward motion of course / localizer pointer;
	As applicable: Confirm: VOR or LOC captured. FMA: Confirm course capture.
When appropriate request: “Gear Down, Flaps 15, Landing Checklist” Set SPEEDBRAKE handle in ARM	Select Gear Down and flap lever to flaps 15. Observe when Gear Down and green lights ON and inform “Gear Down” Inform “Flaps 15” when in position and green light ON. Verify SPEEDBRAKE ARMED light illuminated. Do and read aloud - Landing Checklist.

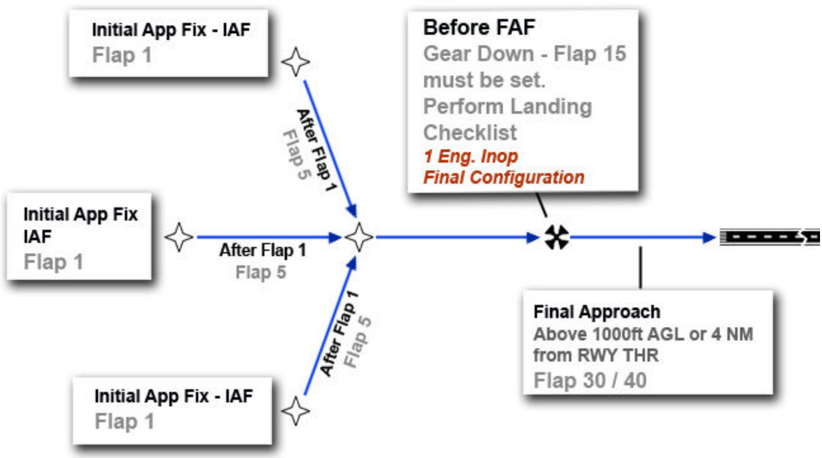
Pilot Flying	Pilot Monitoring
Set or request the next "Step Down Restriction" or "MDA" on MCP	Set the next "Step Down Restriction" or "MDA" on MCP on request
Just before 1000FT AFE, or 4 NM to RWY THR (whichever occur first)	
Request: "Flap _____" (Landing Flap)** set or request VAPP on MCP Request: "Complete Landing Checklist"	Set Flap lever as directed. Do and read aloud- completion of Landing Checklist
1.000FT AFE	
Acknowledge. For the "NOT STABILIZED GO-AROUND" Callout, confirm "GO-AROUND" and perform missed approach procedure.	Inform: "1000 ft" Observe and inform: "STABILIZED" or "NOT STABILIZED-GO-AROUND" (IMC / VMC).
100FT above minimums	
Acknowledge.	Inform: "approaching minimums"
If level off at MDA is needed	
Set Missed Approach Altitude.	Verify Missed Approach Altitude set on MCP.
VDP (V/S mode) and / or MDA +50 feet	
Acknowledge. Night Flight: request "All Lights ON". Inform: "RWY / APP lights in-sight / Not in sight" "Landing or Go-Around".	Inform: "minimums" Turn the retractable landing lights ON (if installed) Acknowledge.
500FT AFE	
Acknowledge.	Inform: "500 ft - wind: _____".
200FT AFE	
Acknowledge.	Inform: "wind: ______".

Note: PM must inform any deviation from standard approach, Flags on instruments and approach not stabilized on COMPANY limits

Perform a Missed Approach if a significant difference exists between LSP / RSP indications in any phase of the approach.
** "Flap 25" may be used as an intermediate position before selecting Landing Flaps at pilot's discretion. This is specially recommended when the Flaps 15 maneuvering speed is too close to the Landing Flaps Placard Speed.

RNAV - APV BARO V-NAV





- Do not use LVL CHG mode after IAF. VNAV should be used or V/S may be used.
- The above pattern is indicated for standard operation. Deviations by ATC, heavy or light gross weight, head or tailwind, must be worked upon.
- VASI and PAPI resources must be used when available.
- Approaches must be obtained from FMC data base. They must contain all fixes as published in the approach chart;

- Check if GPS is installed (FMC - POS INIT page 2/3) and check GPS update ON (FMC - NAV Options page 2/2);
- Approach is not allowed with "UNABLE REQUIRED NAV PERF" displayed on FMC;
- Correct Approach RNP value of 0.3 must be checked on Progress Page 4/4 before commencing the approach;
- Procedure should be performed in LNAV. RNAV (GNSS) only procedures should be flown in VNAV mode;
- BARO V-NAV procedures must be flown in VNAV mode. Otherwise MDA related to "LNAV only" applies;
- Altitude restrictions are set on the MCP considering IAF, FAF and DA. They are released after its compliance is assured and about 2NM prior to the waypoint;
- After FAF and at least 300ft below the missed approach altitude, set the existing Go Around altitude restriction on the missed approach altitude on the MCP;
- When V/S is used, altitude restrictions must be released step by step on the MCP. After its compliance is assured, set the next restriction on the MCP (about 2NM before the next waypoint);
- Altitudes restrictions should be checked, and must remain as "AT OR ABOVE" after the IAF if they are like this on the FMC database, to comply with the FMC Glide Path and prevent unwanted level offs;
- Center map with VSD is the standard display configuration for the Pilot Monitoring during the approach. The Pilot flying display must be in the Expanded MAP Mode;
- GPS or BARO V-NAV course may differ from those of ILS/VOR approach for the same runway.
- As pilot's discretion, consider to edit in the FMC the flap 1 maneuvering speed on the Initial Approach Fix or plan to be with that configuration 15NM prior to the runway on the procedure profile, whichever is closer, as well as with flaps 15 speed on the FAF;
- If the speeds are not edited in FMC, the system logic may assume higher speeds upon Initial Approach Fix and this amount of energy must be worked upon during the approach.

- 3 nm prior FAF, the PF requests “Landing Gear Down, Flaps 15, Landing Checklist”. This will be the final configuration for a One Engine Inoperative approach;
- PM reads aloud and do “Landing Checklist”. Visually confirms flap and gear positions;
- Landing Flaps must be selected on final approach, just before 1.000ft AFE or 4NM from RWY THR. The aircraft must pass 1.000ft AFE in the landing configuration:
- If “MDA” approach is being flown, after FAF, with runway insight and when the aircraft is passing 300 ft below the missed approach altitude, set the missed approach altitude on the MCP;
- If MDA is being flown under IMC, missed approach must be initiated 50 feet before reaching MDA. Disengage Autopilot / Autothrottle in order to land or go-around. .

RNAV (GNSS) OR BARO VNAV APPROACHES	
Pilot Flying	**Pilot Monitoring**
When NAV Radios are not in use for navigation: • Rwy_____; Dry or Wet • Landing Flap; • Autobrake Selection; • Review Missed Approach Procedure; • Set radios for Approach_____ Maintain Expanded MAP Mode. EFIS Control Panel: VOR/ADF, as necessary; Set the final approach course on the MCP. RMI Standby (according to area of responsibility): VOR/ADF bearing pointers as necessary. **Note:** if the local OAT is below 0ºC, altitude corrections must be applied.	“Set Radios” flow procedure: EFIS Control Panel: VOR/ADF switch as necessary; Center Switch (CTR): Press to select VSD on DU if installed. Otherwise the DU should remain in MAP or CTR-MAP. MCP Course: Set; NAV Radios: set frequencies for approach follow up or missed approach; ·Correct Approach RNP value must be checked on Progress Page 4/4. If necessary, set correct value; Check GPS light OFF on the aft overhead panel and GPS update ON (FMC). Inform: “Set Radios for Approach is Completed”.
For straight in approach, plan to be at 3 nm of the FAF with the needed configuration – Flaps 5.	
Request Flaps extension on schedule, up to Flaps 5.	Set Flap lever as directed. Fasten Belts Switch – ON: when “Flap 1” is requested.
Pilot Flying	**Pilot Monitoring**
Before FAF	

Request: “Gear Down, Flaps 15, Landing Checklist” Set SPEEDBRAKE handle in ARM.	Select Gear and flap lever as requested. Callout “Gear Down” when 3 green lights are on. Verify green SPEEDBRAKE ARMED light illuminated. Do and read aloud Landing Checklist.
Just before 1000FT AFE, or 4 NM to RWY THR	
Request: “Flap____” (Landing Flaps)*. Request: “Complete Landing Checklist”.	Select flap lever as directed. Do and read aloud completion of Landing Checklist.

1000FT AFE	
Acknowledge For the ‘NOT STABILIZED GO-AROUND” callout, inform ”GO-AROUND”, and perform a missed approach.	Inform: “1000 ft” Observe and inform: ‘STABILIZED” or “NOT STABILIZED-GO-AROUND” (IMC / VMC).
100FT above minimums	
Acknowledge	Inform: “approaching minimums”
VDP (V/S mode) / MDA +50 feet / DA	
Acknowledge. Night Flight: request “All Lights ON”. Inform: “RWY / APP lights in Sight / Not in sight” “Landing or Go-Around”.	Inform: “minimums” Turn the retractable landing lights ON (if installed) Acknowledge.
500FT AFE	
Acknowledge	Inform: “500 ft - wind:______”.
200FT AFE	
Acknowledge	Inform: “wind:______”.

Note: PM must inform at any time any deviation from standard approach, flags on instruments and not stabilized approach. Perform a missed approach if necessary.

The Flight Directors may be rearmed for VFR approaches, or for an instrument approach if the RWY tracking is different from the final approach course. In other cases maintain the F/Ds ON, as reference, until touchdown.

* “Flap 25" may be used as an intermediate position before selecting Landing Flaps at pilot's discretion. This is specially recommended when the Flaps 15 maneuvering speed is too close to the Landing Flaps Placard Speed.

RNP - AR APCH

- Do not use LVL CHG mode after IAF. VNAV should be used.
- RNP - AR APPROACH CREW REVIEW CARD must be read before the approach;
- RNP - AR operations should not exceed the temperature charts limits;
- Check the Panel Annunciator Status for RNP;
- RNP - AR APCH must be obtained from FMC database. Fixes must comply with the published approach chart. Aircraft database can not be updated in flight;
- Both GPS must be checked ON: FMS: Index > Init/Ref Index > Pos 2/3;
- GPS Update ON; FMS: Index > Nav Data > Nav Options 2/2;
- VOR and DME/DME update must be OFF;
- RAF - RNP Availability Forecast (or RAIM - Receiver Autonomous Integrity Monitoring) must be valid for the time of the approach;
- RNP - AR is not allowed with “UNABLE REQUIRED NAV PERF - RNP”, “FMC DISAGREE” or “VERIFY POSITION” displayed on FMC;
- To provide more situational awareness, insert the FAF on the Fix Page;
- Correct Approach RNP value must be checked on Progress Page 4/4. If necessary, set correct value;
- Set vertical RNP Value to 125ft (progress page 4/4/);
- Altitude restrictions after the IAF should be checked, and must remain as “AT OR ABOVE”;
- Lateral RNP value must be checked after passing each waypoint.
- Set the RNP - AR APCH final course on the MCP. The approach must be performed using LNAV and VNAV;
- Speed restrictions must be observed. Plan to be with Flaps 1 at IAF, or at 15NM before the runway on the procedure profile, whichever is closer;
- Altitude restrictions are set on the MCP considering IAF, FAF and DA. They are released after its compliance is assured and about 2NM prior to the waypoint;

- After FAF and at least 300ft below the missed approach altitude, set the existing Go Around altitude restriction on the missed approach altitude on the MCP;
- 3 nm prior FAF, the PF requests “Landing Gear Down, Flaps 15 and Landing Checklist”. This will be the final configuration for a One Engine Inoperative. Earlier configuration may be needed to comply with speed restrictions of the procedure;
- Monitor VNAV PATH mode. If reversion to VNAV SPEED occurs, use SPD INTV to intercept the correct vertical path and reengage VNAV PATH mode;
- The procedure must be flown on autopilot until VFR or the DA, when the A/P should be disengaged in order to land or go around, as applicable;
- Maintain the Flight Directors ON, as reference, until touchdown;
- For SDU operations specific normal or contingency procedures check the respective Airport Briefing Chart.

<table>
<tr><th colspan="2">RNP AR APCH</th></tr>
<tr><th>Pilot Flying</th><th>Pilot Monitoring</th></tr>
<tr><td>When NAV Radios are not in use for navigation:
• Rwy_____; Dry or Wet
• Landing Flap;
• Autobrake Selection;
• Review Missed Approach Procedure;
• Set Radios for Approach_____
Maintain Expanded MAP Mode.
EFIS Control Panel: VOR/ADF switch as necessary;
Set the final approach course on the MCP.
RMI Standby (according to area of responsibility): VOR/ADF bearing pointers as necessary.
Note:
• Verify the temperature and speed limits on the approach.
• The PF must ensure that the RAF (RNP Availability Forecast) is valid for the time of the approach.</td><td>“Set Radios” flow procedure:
Set the RNP-AR APCH final course on the MCP
Center Switch (CTR): Press to select VSD on the Pilot Monitoring DU.
• FMS: Index > Init/Ref Index > Pos > Pág 2/3 Check both GPS ON;
• Nav Options page 2/2:
• GPS update ON;
• VOR and DME/DME update OFF;
• Correct Approach RNP value must be checked on Progress Page 4/4. If necessary, set correct value;
• Set vertical RNP Value to 125 ft (progress page 4/4 LSK 2R)
Check GPS light OFF on the aft overhead panel</td></tr>
<tr><td>Request Flaps extension on schedule up to Flaps 5</td><td>Set Flap lever as directed.
Fasten Belts Switch – ON: when “Flap 1” is requested.</td></tr>
<tr><th colspan="2">Before FAF**</th></tr>
<tr><td>Request: “Gear Down, Flaps 15, Landing Checklist”

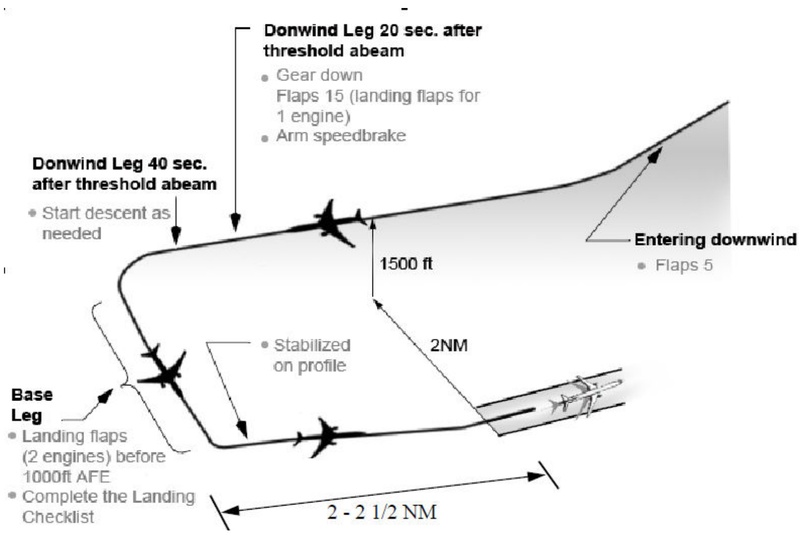
Set SPEEDBRAKE handle in ARM.

**Check speed restrictions on the approach. Earlier configuration may be needed</td><td>Select gear and flap lever as requested.
Callout “Gear Down” when 3 green lights are on.
Verify green SPEEDBRAKE ARMED light illuminated.
Do and read aloud the Landing Checklist.</td></tr>
</table>

Pilot Flying	Pilot Monitoring
After FAF and at least 300ft below the missed approach altitude	
Set the existing Go around altitude restriction or the missed approach altitude on the MCP.	Verify if the MCP is correctly set.
Before 1000FT AFE	
Request Landing Flaps: “Flaps __”. Request: “Complete Landing Checklist”.	Select flap lever as directed. Do and read aloud the final part of the Landing Checklist.
1000FT AFE	
Acknowledge For the ‘NOT STABILIZED GO-AROUND” callout, inform ”GO-AROUND”, and perform the MISSED APPROACH	Inform: “1000 ft” Observe and inform: ‘STABILIZED” or “NOT STABILIZED-GO-AROUND”
500FT AFE	
Acknowledge	Inform: “500 ft - wind:______”.
100FT above minimums	
Acknowledge	Inform (If auto callout not installed): “approaching minimums”
200FT AFE	
Acknowledge	Inform: “wind:______”.
DA	
Acknowledge Disengage Autopilot / Autothrottle Night Flight: request “All Lights ON” Inform: ”RWY / APP lights in sight / not in sight” “Landing or Go-Around”.	Inform (If auto callout not installed): “Minimums”. Turn the retractable landing lights – ON (if installed).

Note: PM must inform any deviation from standard approach, flags on instruments and approach not stabilized on COMPANY limits. If necessary perform a missed approach.

Visual Approach



- Select Flap 5 before entering downwind leg;
- Abeam of landing threshold start chronometer;
- 20 seconds after threshold, select Landing Gear down and Flaps 15, perform Landing Check List (this will be the final configuration for a One Engine Inoperative Landing);
- 40 seconds after threshold turn to base leg;
- Select Landing Flaps just before 1000ft AFE, in order to have the aircraft in the landing configuration at 1000ft AFE;
- Glide Slope, VASI and PAPI resources must be used when available.

VISUAL APPROACHES	
Pilot Flying	**Pilot Monitoring**
When cleared for approach confirm conditions: • Rwy; • Dry or Wet; • Landing Flap; • AUTOBRAKE Selection; • Use as available ILS, VOR, ADF or GPS as guides for approach. **Note:** if a Go-around procedure is needed, proceed to the visual traffic pattern.	Adjust: "Panel or Radios" according to the PF request. If applicable, before starting visual traffic pattern, insert on FMC Approach page a runway extension fix (RX) of 2 NM as reference for the final approach. The aircraft should be at 600ft AFE over this point in order to be in the correct path (300ft for each NM distance to the threshold).
BEFORE DOWNWIND LEG	
Request flaps extension on schedule up to Flaps 5.	Set Flap lever as directed. Monitor extension and inform new flaps configuration when in position and green light ON. Seat Belt Switch ON when "Flaps 1" is requested
ABEAM LANDING THRESHOLD	
Start chronometer.	Start chronometer.
20 seconds: request: "Gear Down, Flaps 15, Landing Checklist". Set or request Flaps 15 speed on the MCP. SPEEDBRAKE handle - ARM	Select Gear Down and flap lever to flaps 15. Verify SPEEDBRAKE ARMED light illuminated. Do and read aloud - Landing Checklist.
40 seconds: start base turn	
JUST BEFORE 1000FT AFE	
Request: "Flap___" (Landing Flap)* just before 1000ft AFE set or request VAPP on the MCP. Request: "Complete LANDING CHECKLIST"	Select flap lever as directed just before 1000ft AFE. Do and read aloud- completion of LANDING CHECKLIST.
Pilot Flying	**Pilot Monitoring**

AT 1000FT AFE	
Acknowledge For the 'NOT STABILIZED GO-AROUND" callout, inform: "GO-AROUND", and perform the MISSED APPROACH	Inform: "1000 ft" Observe and inform: 'STABILIZED" or "NOT STABILIZED-GO-AROUND"
500FT AFE	
Acknowledge Night Flight: request "All Lights ON".	Inform: "500 ft - wind:______". Night Flight: Turn the retractable landing lights ON (if installed).
200FT AFE	
Acknowledge	Inform: "wind:______".

Note: PM must inform any deviation from standard Approach, Flags on instruments and Approach not stabilized on COMPANY limits.

* "Flap 25" may be used as an intermediate position before selecting landing flaps at pilot's discretion. This is specially recommended when the Flaps 15 maneuvering speed is too close to the Landing Flaps Placard Speed.

Go-around and Missed Approach Procedures

Threat and errors associated with this phase of flight are:

- *Improper aircraft configuration;*
- *Altitude restrictions exceedances;*
- *Upset aircraft attitudes;*
- *Not verbalizing FMA and MCP changes;*
- *Lack of pilot's dual check prior to FMC changes;*
- *Complacency in Autopilot and Autothrottle;*

These items are not limited to and pilots are expected to anticipate any threat.

<table>
<tr><th colspan="2">Go–around and missed approach procedures</th></tr>
<tr><th>Pilot Flying</th><th>Pilot Monitoring</th></tr>
<tr><td>Inform decision: “Go-Around”.
Disengage Autopilot
Push TOGA switch and advance thrust levers to Go-Around Thrust

Rotate to Go Around Attitude

Request “Flaps 15”

If needed, push the TOGA switch a second time to obtain full Go Around Thrust</td><td>Verify / adjust Go-Around Thrust.
“Go-Around Thrust Set”

Set flap lever to “15”
Observe Flap Position indication and inform when flap reaches selected position.</td></tr>
<tr><td colspan="2">Verify:
• Rotation to go-around attitude;
• That the thrust increases.</td></tr>
<tr><th colspan="2">When a positive rate of climb is indicated on the altimeter</th></tr>
<tr><td></td><td>Inform: “positive rate"</td></tr>
<tr><td>Request: “Gear Up”</td><td>Select gear lever to UP.
Inform Gear position when UP.</td></tr>
<tr><th colspan="2">400FT AFE</th></tr>
<tr><td>Request or monitor: “LNAV” or “HDG SEL"</td><td>Select or monitor the Roll mode as directed</td></tr>
<tr><td>Request: “Set radios for missed Approach”
Above 400ft Autopilot may be selected ON. Engage in “CMD”
For A/P ON - select Autothrottle ON</td><td>Select / tune NAV RADIOS as directed
Verify missed approach route is tracked.

Verify FMA and Inform: “Autopilot CMD” and autothrottle mode.</td></tr>
<tr><th colspan="2">Above 1000FT AFE</th></tr>
<tr><td>Request: “FLAPS ___” according to flap retraction schedule.</td><td>Set the FLAP lever as directed.
Monitor flaps and slats retraction.
Inform each new flap position.</td></tr>
<tr><th colspan="2">After Flaps are UP</th></tr>
<tr><td>Request or set: LVL CHG or VNAV

Request: “AFTER TAKEOFF CHECKLIST”
Note: with the aircraft stabilized the Autopilot and Autothrottle may be selected ON above 400ft AGL.</td><td>Do (read aloud) “After takeoff checklist”
Inform “After takeoff checklist completed”</td></tr>
</table>

Go–around and missed approach procedures ILS CAT II	
Pilot Flying	**Pilot Monitoring**
Inform decision: "Go-Around". Push TOGA switch	
Monitor A/P rotates to go–around attitude; Monitor A/T sets go–around Thrust.	
Push TOGA switch again to obtain full Go-around N1 thrust (if necessary)	Verify / adjust Go-Around Thrust
Request: "Flaps 15".	Select flap lever to "15". Observe Flap Position indication and inform when flap reaches selected position.
When a positive rate of climb is indicated on the altimeter	
Request: "Gear Up"	Inform: "positive rate". Select gear lever to UP. Inform gear position when UP.
400FT AFE	
Set or monitor: "LNAV"	Select or monitor the Roll mode as directed
Request: "Set radios for missed Approach".	Select / tune NAV RADIOS as directed. Verify missed approach track is available.
Above 1000FT AFE	
Request: "FLAPS ___" according to flap retraction schedule.	Set the FLAP lever as directed. Monitor flaps and slats retraction. Inform each new flap position.
After Flaps are UP	
Request or select: LVL CHG or VNAV Request: "AFTER TAKEOFF CHECKLIST"	Do (read aloud) "After takeoff checklist" Inform "After takeoff checklist completed"

Reject Landing

Reject landing is a Go-around maneuver initiated after touchdown, however, it cannot be safely initiated after the deployment of the thrust reversers.

Landing

Threat and errors associated with this phase of flight are:

- *Long flare;*
- *Touchdown beyond AIMING POINT;*
- *Adverse weather conditions;*
- *Lack of reject landing decision;*
- *Lack of aborted landing decision;*
- *Tail strike pitch attitude (degrees): B700 12,3º, B800 9,2º. B800 SFP 8,8º, BMAX8 8,8º*
- OPT Landing Flare distance.

These items are not limited to and pilots are expected to anticipate any threat.

Landing Checklist

PF: Request: “Landing checklist”

PM: do (read aloud) the requested checklist

LANDING	
ENG START SWS	CONT (PF)
ALTIMETERS	SET AND X-CHECKED (PF)
SPEEDBRAKE	ARMED (PF)
LANDING GEAR	DOWN (PF)
FLAP	_____ GREEN LT (PF)
RUNWAY CHANGE REPEAT LANDING CHECKLIST	

PM: inform “Landing checklist completed”

Circling Approaches

As determined by company policy, the Circling Approaches can only be performed when authorized in the Airport Briefing chart. In this case the weather minimums must be always greater than:

- Visibility 5.000m;
- Ceiling 1.500ft.

For SBRJ - Santos Dumont special operations, some IFR approach procedures are considered as “Circle to Land” due to the difference between the final approach course and the runway tracking. In this case the weather minimums of the approach chart apply.

Circling Approaches Missed Approach

If a missed approach is needed at any time while circling, make an initial climbing turn toward the land runway and intercept the missed approach profile.

Landing Roll Procedure - PF, PM

Pilot Flying	Pilot Monitoring
Verify that the thrust levers are closed. Without delay, move the reverse thrust levers to the interlocks and hold light pressure until the interlocks release. Then apply reverse thrust as needed.	
Move SPEEDBRAKE UP manually if necessary	Verify SPEEDBRAKE lever position and inform “SPEEDBRAKES UP”. Or “SPEEDBRAKES NOT UP”.
Verify correct AUTOBRAKE operation. When disarming the AUTOBRAKE. Inform: “MANUAL BRAKING”	Verify the Reverser light indication on upper display and inform “REVERSERS NORMAL”, for both REV indications green. If there is no REV indication(s) or the indication(s) stays amber, call “NO REVERSER ENGINE NUMBER 1”, or “NO REVERSER ENGINE NUMBER 2”, or “NO REVERSERS”. Verify and inform “AUTOBRAKE DISARM” Inform “60 KNOTS.”

Pilot Flying	Pilot Monitoring
Apply reverse thrust as needed. By 60 knots, start movement of the reverse thrust levers to be at the reverse idle detent before taxi speed. After the engines are at reverse idle, move the reverse thrust levers full down.	
Start Chronometer.	Start Chronometer.
Use manual braking as needed.	

Reverse Thrust (use)

Reversers are more effective at high speeds. Good landing technique recommends that the thrust reversers are actuated to idle as soon as main landing gears are on the ground.

Afterwards, they are commanded to the 2nd detent, exception for the idle Reverse Operation, when allowed.

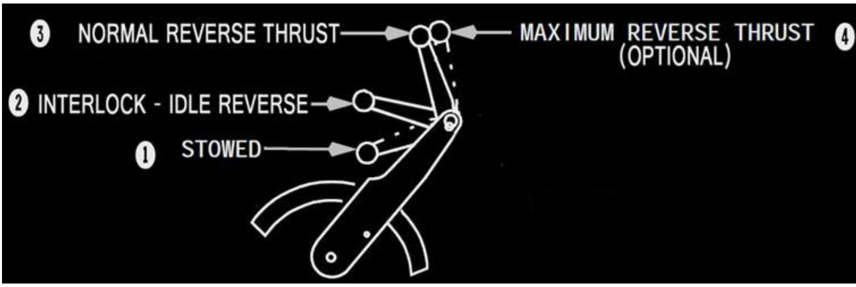
Maintain actuation until 60 kt.

The PM must confirm **“Reversers normal”** when both Reverse indications on upper display are green, **“No Reverser Engine Number 1" or “No Reverser Engine Number 2"** when one of the indications is amber, and **“No Reversers”** when both indications are amber.

Remove reverse thrust smoothly in order to attain idle thrust before taxi speed.

Only return the reverse thrust lever to the stowed position after engine thrust is approaching idle.

WARNING: After the reverse thrust levers are moved, a full stop landing must be made. If an engine stays in reverse, safe flight is not possible.



After landing procedures

Start the After Landing Procedure only when clear of the active runway or initiating back track.

Taxi instructions, assistance to the pilot taxiing and monitoring of other aircraft nearby will have priority over this procedure.

If the Airport Briefing informs that the "single engine taxi in" is not applicable, some changes on the after landing procedures concerning on when to turn on the APU apply.

F/O performs the procedures after the Captain retracts speedbrakes.

Chronometer .... Start when reverse levers are stowed (C, F/O)

Speedbrake .... Down (C)

Retract the speedbrakes lever manually and push it down firmly.

Flap lever .... UP (F/O)

Landing / RWY turn off / Taxi light ...... As required (see note) (F/O)

Engine Start switches .... OFF (F/O)

Strobe Lights / Wing Illumination Lights .... OFF (F/O)

Weather Radar / TERR .... OFF (C, F/O)

Center Switches (CTR) .... Select MAP (C, F/O)

Autobrake switch .... OFF (F/O)

MFD .... ENG (F/O)

Select to show secondary engine indications on the Lower DU.

Stab Trim.. 5 Units (F/O)

Transponder .... As Required (F/O)

Set the transponder mode selector as needed.When crossing runaway or backtracking set transponder ON. At airport where ground tracking is not available, select STBY. At airport equipped to track airplanes on the ground, select an active transponder setting, but not TCAS mode.

APU (if available) ....START (F/O)

Wait the following periods after the reversers are stowed to start the APU:

• 2 minutes if reverse thrust was used during the landing roll-out;

• 1 and a half minute if idle reverse thrust was used during landing;

If the Single Engine Taxi In will not be performed or if the APU will not be used during this operation, start the APU when it is estimated to be remaining 1 minute to shut down the engine(s).

APU Generator switches..ON BUS (F/O)

If Single Engine Taxi In is going to be performed:

Request the engine to be shutdown (C)

Engine Start Lever (engine to be shutdown).............. CUTOFF (F/O)

•Observe the 3 minutes cooldown period or;

•If idle reverse was used for landing observe the 2 and a half minutes cooldown period.

•If the APU is not available, shutdown the Engine No. 2.

•Single Engine Taxi In should be performed even with inoperative APU.

Note: the air systems configuration table used on the single engine taxi out procedures may be followed to provide additional cooling.

- Landing lights may be turned off only in accordance with the captain;
- Taxi lights modifications may only be performed upon the captain request;
- Request taxi light OFF when approaching the parking stand;
- Weather Radar, TERR and Center Switches must be selected according to the area off responsibility;

- During “taxi in” it is prohibited to the first officer to perform procedures other than those related as “after landing procedures” and assisting the Captain. The MCP, overhead panel and FMC should not be prepared to the next flight at this time.

CAUTION: Single Engine Taxi In is not permitted over slippery taxiways. It may be performed over dry or wet surfaces.

Shutdown Procedures

Start the Shutdown Procedures after aircraft comes to a complete stop.

PARKING BRAKE .... Set (C)

Verify warning light is illuminated.

Check Electrical Power.

Engine start levers..Cutoff (C)

Operate the engines at or near idle thrust for a minimum of three minutes before shutdown to thermally stabilize the engines and reduce undercowl soak-back temperatures. This time period is a recommendation, not an engine limitation.

Note: if idle reverse thrust is used during the landing rollout the cooldown time should be of two and a half minutes.

Routine cooldown times of less than three minutes or less than two and a half minutes (after an idle reverse landing) before engine shutdown can cause engine degradation.

If APU is not available shut down ENG No. 2 and after Ground Power is available and on bus shut down ENG No.1.

Fuel Panel .... Check (C)

Note: check SPAR VALVE Closed light. It illuminates bright when fuel control switches or engine start levers are moved to cutoff and remains illuminated DIM with engines shut down.

FASTEN BELTS switch .... OFF (F/O)

Set immediately after the engines are shutdown.

ANTI COLISION LIGHT switch...................................... OFF (F/O)

Set immediately after the Fasten Belts switch is placed OFF.

PARKING BRAKE .... Set (C)

Release the Parking Brake only after Ground Staff confirms the airplane is on chocks. Release the brakes smoothly to prevent unwanted aircraft movement. Make sure the aircraft does not move after parking brake is released.

After Parking Brake is released and aircraft is confirmed to be parked:

FUEL PUMP switches .... OFF (F/O)

Note: whenever the APU is running and AC electrical power is on the buses, turn on one fuel bust pump to supply fuel under pressure to the APU to extend the service life of its fuel control unit.

CAUTION: Do not operate the center tank fuel pumps with the flight deck unattended.

WING ANTI-ICE switch .... OFF (F/O)

ENGINE ANTI-ICE switches .... OFF (F/O)

ELECTRIC HYDRAULIC PUMPS .... OFF (F/O)

ISOLATION VALVE switch .... OPEN (F/O)

APU BLEED air switch .... ON / OFF (F/O)

If temperature allows, switches APU Bleed - OFF to reduce the APU fuel flow. Run the APU for 1 minute before using it as pneumatic air source.

WEATHER RADAR .... (Confirm) OFF (C, F/O)

Flight Director switches .... OFF (F/O)

MCP speed cursor .... 100 (F/O)

FUEL FLOW .... Reset (F/O)

Engine Oil Quantity .... Check (C, F/O)

Check above minimum for the next flight (70% or 15 quarts). if not, advise ground staff that an oil service will be required.

Audio Control Panel .... Set (C, F/O)

Markers .... OFF

Speakers .... ON

TRANSPONDER .... STBY / 2000 (F/O)

Transponder with AUTO feature should be left in this position and only TCAS should be cycled to OFF/STBY.

VHF NAVIGATION radios .... Non-ILS Frequency (F/O)

FMC POS REF page 2 .... Verify INS GS (C)

Verify IRS left and right residual Ground Speed, at maximum 2 minutes after shutting down engines. Ground speed above 15kt requires maintenance action, and must be reported in the Technical Log.

FLIGHT DECK DOOR ....Unlock (F/O)

Verify that the CABIN DOOR UNLOCKED light is illuminated.

ACARS data...Send (F/O)

POST FLIGHT page:

POST FLIGHT REPORT page:

Enter who performed the takeoff (CAPT/F.O.).

Enter who performed the landing (CAPT/F.O.).

Enter Category Landing.

Enter Fuel Onboard.

Enter if performed AUTOLAND.

Click SEND.

If external power is available and will be used on ground time:

Verify that the GRD POWER AVAILABLE light is illuminated.

GRD POWER switch ....ON (F/O)

Verify that the SOURCE OFF lights are extinguished.

APU switch .... OFF (F/O)

Shutdown Checklist

(C): Call "Shutdown Checklist"

(F/O): Do the requested Checklist

SHUTDOWN		
ANTICOLLISION LIGHT	OFF	(F/O)
WEATHER RADAR	OFF	(BOTH)
ENGINE START LEVERS	CUTOFF	(C)
PARKING BRAKE	AS REQD	(C)
TRANSPONDER	STBY	(F/O)

(F/O): Inform "Shutdown Checklist completed"

Secure Checklist

Perform this procedure when:

- Aircraft will stay overnight;
- Crew change (not immediately);
- Considerable aircraft ground time with crew on board.

IRS mode selectors ....OFF (C)

CAB/UTIL power switch (as installed) ....As required (F/O)

Switching CAB/UTIL OFF in Sky Interior equipped aircraft will remove power from the LED cabin lightning.

IFE/PASS SEAT power switch (as installed) ....As required (F/O)

GALLEY power switch (as installed) .... OFF (F/O)

EMERGENCY EXIT LIGHTS switch .... OFF (F/O)

WINDOW HEAT switch .... OFF (F/O)

AIR CONDITIONING PACK switches ....As needed (F/O)

EXTERIOR LIGHTS ....As required (F/O)

APU / GRD POWER switch ....As required (F/O)

TRIM AIR SWITCHES (as installed) .... OFF (F/O)

DU illumination .... DIM (C, F/O)

EFB ....OFF (C, F/O)

(C): Call "Secure Checklist"

(F/O): Do the requested Checklist.

SECURE		
IRS	OFF	(F/O)
EMERGENCY EXIT LIGHTS	OFF	(F/O)
WINDOW HEAT	OFF	(F/O)
PACKS	OFF	(F/O)

(F/O): Inform: "Secure Checklist completed".

Note: if a subsequent flight is to be performed, the Preflight procedure must be done and the preflight checklist must be read once again before this new flight.

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Supplementary Procedures — Chapter SP

Table of Contents — Section TOC

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Supplementary Procedures — Chapter SP
Introduction — Section 05

General

This section contains procedures (adverse weather operation, engine crossbleed start, and so on) that are accomplished as required rather than routinely performed on each flight.

Supplementary procedures may be required because of adverse weather, unscheduled maintenance or as a result of a procedure referenced in a Non–Normal Checklist. Additionally, some may be performed if the flight crew must accomplish preflight actions normally performed by maintenance personnel.

At the discretion of the Captain, procedures may be performed by memory, by reviewing the procedure prior to accomplishment, or by reference to the procedure during its accomplishment.

Supplementary procedures are provided by section. Section titles correspond to the respective chapter title for the system being addressed except for the adverse weather section.

Note: The pound symbol (#) indicates supplementary procedures of significant importance that may be more routinely used, and due to that will also be available on the QRH - Quick Review Chapter.

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Interior Inspection

Emergency exit lights .... Check

Passenger signs .... Check

Service and entry doors .... Check

Escape slides .... Check pressure

Emergency exits .... Check

Wing upper surfaces .... Check

Lavatory fire extinguishers .... Check

Emergency equipment .... Check

Check availability and condition of emergency equipment, as required.

#Jumpseat Briefing

- People traveling on the cockpit jumpseats must be briefed on:
- How to arm and disarm such seats (if applicable)
- The use of the seat belts, including the shoulder harness
- Test and use of the oxygen masks.
- Sterile cockpit philosophy
- The use of the cockpit door locking mechanism
- Available emergency equipment and evacuation routes, including the use of the escape rope through the cockpit window

Note: Pilots traveling on the cockpit must be encouraged to speak out issues that can positively affect the flight, including safety related issues.

Flight with Supernumeraries

For flights without flight attendants and people other than crewmembers on board.

The following procedures must be made in addition to the Cabin Inspection Supplementary Procedure before each flight with supernumeraries or if the aircraft has been unattended by a flight crew or cabin crew for any period of time.

Before the Flight

The availability, accessibility and serviceability of the emergency systems and equipment must be checked.

All supernumeraries must be briefed by one of the pilots on the safety information:

- How and when to communicate with the cockpit using the service interphone;
- In case of an emergency, such as medical situations, fire or fumes on board, the cockpit must be immediately contacted;
- The location of the emergency exits and its operation (including the escape slides);
- The location and operation of emergency equipment for collective use (this information is available on the Cabin Emergency and Loose Equipment Card displayed on the galleys);
- Location of life jackets or use of the seat cushion for flotation and lifesaving rafts (if applicable);
- Use of oxygen masks;
- The evacuation is to be commenced regardless of any previous command from the cockpit in case of ditching, uncontrollable fire or smokes or structural damage;
- The prohibition of smoke on board;
- When to use the seat belts;
- The proper stowage of the carry on baggage, with the overhead bins closed;

Most of this information is also available in the passenger safety cards, located in the seat pockets. Additional information pertaining to restrictions to the takeoff and landing phases are located on this card and must be followed.

Additionally, the seat belts must be used whenever the Fasten Seat Belts sign is ON. The sign will be ON during the following phases of flight:

- During taxi
- Takeoff and landing phases
- Prior to and / or during turbulence
- During an emergency situation, if necessary
- Before the first aircraft movement the PA must be used in order to give instructions to the persons on board to remains seated with the seat belts fastened, which will make the cabin ready for departure.

Before Takeoff

The imminent takeoff must be announced on the PA in accordance to the SOP, reinforcing the need to remain seated with the seat belts fastened.

During the Flight

If turbulence is expected or encountered the Fasten Seat Belts sign must be switched ON and an announcement is to be made on the PA regarding to the turbulence instructing the persons on board to remain seated with the seat belts fastened.

Before Landing

The imminent landing must be announced on the PA in accordance to the SOP, reinforcing the need to remain seated with the seat belts fastened.

Emergency Situations

Proper communication through the PA system must be used whenever an immediate response is expected from the persons on board, such as "use masks", prepare for impact, "standby further instructions" or "initiate an evacuation through the emergency exits".

#Flight Deck Door Access System Test

Flight Deck Access System switch ....NORM

Flight deck door .... Open

Flight deck door lock selector ....AUTO

Emergency access code .... Enter

ENT key .... Push

Verify alert sounds.

Verify AUTO UNLK light illuminates.

Flight deck door lock selector ....DENY

Verify AUTO UNLK light extinguishes.

Flight deck door lock selector ....UNLKD

Flight deck access system switch .... OFF

Verify LOCK FAIL light illuminates.

Flight deck access system switch ....NORM

Guard - Down

Verify LOCK FAIL light extinguishes.

Water System Draining

Lavatory water supply selector valves .... SUPPLY/DRAIN

Galley water supply shutoff valves .... SUPPLY ON

The shutoff valve is found adjacent to each wet galley sink.

Drain line .... Connect to drain ports

- below the main passenger entry door
- aft of the water service panel

Water service panel .... Open

Tank drain valve handle .... OPEN

Drains potable water tank and water system aft of the wings.

Forward lavatory drain valve .... OPEN

Drain valve is found below the sink in the forward lavatory only.

Drain valves for coffee maker and
water boiler (if installed) .... OPEN

All galley and lavatory water faucets .... Open

Close faucets when water flow stops.

Accomplish the following items after verifying the potable water system is empty:

Drain valves for coffee maker and
water boiler (if installed) .... CLOSED

Forward lavatory drain valve .... CLOSED

Tank drain valve handle .... CLOSED

Water service panel .... Close

Drain line .... Disconnect from drain ports

If the potable water tank will not be refilled immediately after the system is emptied, open the following circuit breakers and attach DO–NOT–CLOSE tags:

P18–3 circuit breaker panel

- LAVATORY WATER HEATER A
- LAVATORY WATER HEATER D
- LAVATORY WATER HEATER E

Power distribution panel number 1
- POT WATER COMPRESSOR
- WATER QTY IND

Oxygen Mask Microphone Test

MASK/BOOM switch .... MASK

FLT INT switch .... Push

SPKR switch .... On

RESET/TEST switch .... Push and hold

EMERGENCY/Test selector .... Push and hold

Push-to-Talk switch .... INT

Simultaneously push the Push-to-Talk switch, the EMERGENCY/Test selector and the RESET/TEST switch.

Verify oxygen flow sound is heard through the flight deck speaker.

Push-to-Talk switch .... Release

EMERGENCY/Test selector .... Release

RESET/TEST switch .... Release

SPKR switch .... As needed

MASK/BOOM switch .... BOOM

ETOPS

Operators conducting ETOPS are required to comply with appropriate regulations. An operator must have an ETOPS configured and approved airplane, and approved flight operations and maintenance programs in place to support ETOPS.

APU Operation

Unless otherwise authorized, start the APU before the ETOPS segment. The APU must be on for the entire ETOPS segment.

Fuel Crossfeed Valve Check

Unless accomplished by maintenance personnel prior to the ETOPS flight, do the following steps on the ground prior to engine start:

Crossfeed selector .... Open

Verify that the VALVE OPEN light illuminates bright, then dim.

Crossfeed selector ....Close

Verify that the VALVE OPEN light illuminates bright, then extinguishes.

During the last hour of cruise, do the following steps:

Crossfeed selector .... Open

Verify that the VALVE OPEN light illuminates bright, then dim.

Crossfeed selector ....Close

Verify that the VALVE OPEN light illuminates bright, then extinguishes.

Wing–Body Overheat Test

Wing–body OVHT TEST switch .... Push

Hold for a minimum of 5 seconds.

Both WING–BODY OVERHEAT lights – illuminated

MASTER CAUTION – illuminated

AIR COND system annunciator – illuminated

Wing–body OVHT TEST switch .... Release

Both WING–BODY OVERHEAT lights – extinguished

MASTER CAUTION lights – extinguished

AIR COND system annunciator – extinguished

Air conditioning from a Ground Pneumatic Cart (LPU)

This procedure is used when using a pneumatic cart to supply pressurized air to the air conditioning packs.

CAUTION: The BAT switch should always be on when using the airplane air conditioning system since the protective circuits are DC. This ensures protection in the event of loss of AC power.

Note: For engine start with a ground air source, see section SP.7.

APU BLEED air switch .... OFF

ISOLATION VALVE switch .... OPEN

RECIRC FAN switches .... AUTO

Trim Air Switch (as installed) .... ON

PACK switches .... AUTO or HIGH

Cabin temperature selectors .... AUTO

Set for desired temperature.

Duct pressure .... 20 psi minimum

If external air cannot hold 20 psi minimum and the APU is operating:

ISOLATION VALVE switch .... AUTO

APU BLEED air switch .... ON

APU supplies left pack and external air source supplies right pack.

Air Conditioning from an External Air Conditioning Unit (ACU)

Before connecting ground conditioned air:

PACK switches ....OFF

Packs can be damaged if they are operated while ground conditioned air is connected.

After disconnecting ground conditioned air:

PACK switches .... As needed

Isolated Pack Operation during Engine Start

To improve cabin air quality between starting the first and second engine:

CAUTION: Moving engine BLEED air switches while a starter is engaged can damage the starter.

Engine No. 2 ....Start

After engine No. 2 stabilized:

ISOLATION VALVE switch. .... CLOSE

Right PACK switch. .... AUTO

Duct pressure. .... Stabilized

Engine No. 1. ....Start

After engine No. 1 stabilized:

ISOLATION VALVE switch.. AUTO

Pressurization System Manual Mode Test

PACK switches ....OFF

Pressurization mode selector ....MAN

AUTO FAIL and ALTN lights – extinguished.

MANUAL light – illuminated.

Outflow valve switch .... CLOSE

Verify outflow valve position indicator moves toward CLOSE.

Outflow valve switch .... OPEN

Verify outflow valve position indicator moves toward OPEN.

Pressurization mode selector ....AUTO

Verify outflow valve position indicator moves toward OPEN.

MANUAL light – extinguished.

Manual Mode Operation

CAUTION: Switch actuation to the manual mode causes an immediate response by the outflow valve. Full range of motion of the outflow valve can take up to 20 seconds.

Pressurization mode selector .... MAN

MANUAL light – illuminated

CABIN/FLIGHT ALTITUDE placard.. Check

Determine the desired cabin altitude.

If a higher cabin altitude is desired:

Outflow valve switch (momentarily) ....OPEN

Verify the outflow valve position indicator moves right, cabin altitude climbs at the desired rate, and differential pressure decreases. Repeat as necessary.

If a lower cabin altitude is desired:

Outflow valve switch (momentarily) ....CLOSE

Verify the outflow valve position indicator moves left, cabin altitude descends at the desired rate, and differential pressure increases. Repeat as necessary.

During Descent

Thrust lever changes should be made as slowly as possible to prevent excessive pressure bumps.

Outflow valve switch (momentarily) .... CLOSE

During descent, intermittently position the outflow valve switch toward CLOSE, observing cabin altitude decrease as the airplane descends.

Before entering the landing pattern, slowly position the outflow valve to full open to depressurize the airplane. Verify differential pressure is zero.

#Pressurization Control Operation – Landing at Alternate Airport

At top of descent:

LAND ALT Indicator .... Reset

Reset to new destination field elevation.

Automatic Pressurization Control – Departure Airport Elevation Above 8400 Feet

If departure airport elevation is above 10,000 feet:

Oxygen masks and regulators ....ON, Normal

Supplemental oxygen must be used from departure until the cabin altitude is below 10,000 feet.

After electrical power is applied to the airplane:

HIGH ALT LDG switch .... Off

Monitor CABIN ALT and CABIN rate of CLIMB indicators during climbout to ensure cabin altitude is descending below 8500 feet, at which time the cabin altitude warning system is reset to 10,000 feet.

Note: If departure airport elevation is above 9000 feet, the high altitude landing mode may be active and the warning system set at the High Altitude setpoint. If departure airport elevation is above 11,000 feet, the high altitude landing mode will be active and the warning system set at the High Altitude setpoint. When the cabin altitude descends below 8500 feet, the cabin altitude warning system is reset to 10,000 feet.

If landing altitude is at or below 6000 feet:

LAND ALT indicator .... Destination field elevation

If landing altitude is above 6000 feet:

Do the Automatic Pressurization Control - Landing Airport Elevation Above 6000 Feet supplementary procedure.

Return to Departure Airport is Needed

HIGH ALT LDG switch .... ON

If landing elevation is above 10,000 feet:

Oxygen masks and regulators .... ON, Normal

Supplemental oxygen must be used anytime the cabin altitude is above 10,000 feet.

Automatic Pressurization Control – Landing Airport Elevation Above 6000 Feet but 8400 Feet and Below

Do the normal Preflight Procedure - First Officer except as modified below.

Prior to takeoff:

LAND ALT indicator .... 6000 feet

At initial descent:

LAND ALT indicator .... Destination field elevation

Automatic Pressurization Control – Landing Airport Elevation Above 8400 Feet

Do the normal Preflight Procedure - First Officer except as modified below.

Prior to takeoff:

LAND ALT indicator .... 6000 feet

At initial descent or approximately 20 minutes prior to landing:

If landing elevation is above 8400 feet:

HIGH ALT LDG switch .... ON

If landing elevation is above 10,000 feet:

Oxygen masks and regulators .... ON, Normal

Supplemental oxygen must be used anytime the cabin altitude is above 10,000 feet.

LAND ALT indicator .... Destination field elevation

#Unpressurized Takeoff and Landing

When making a no engine bleed takeoff or landing with the APU inoperative, or operative but not providing bleed air:

Takeoff

PACK switches .... AUTO

ISOLATION VALVE switch .... CLOSE

Engine BLEED air switches...OFF

APU BLEED air switch ....OFF

After Takeoff

Note: If engine failure occurs, do not position engine BLEED air switches ON until reaching 1500 feet or until obstacle clearance height has been attained.

After first flap retraction:

Engine No. 2 BLEED air switch .... ON

When CABIN rate of CLIMB indicator stabilizes and workload permits at pilot’s discretion:

Engine No. 1 BLEED air switch .... ON

ISOLATION VALVE switch... AUTO

Landing

When below 10,000 feet and starting the turn to final approach:

Engine BLEED air switches ....OFF

Avoid high rates of descent for passenger comfort.

#No Engine Bleed Takeoff and Landing

When making a no engine bleed takeoff or landing with the APU operating.

Takeoff

Note: If anti–ice is required for taxi, configure for a "No Engine Bleed Takeoff" just prior to takeoff.

Note: If anti–ice is not required for taxi, configure for a "No Engine Bleed Takeoff" just after engine start.

Right PACK switch ....AUTO

ISOLATION VALVE switch .... CLOSE

Left PACK switch ....AUTO

Engine No. 1 BLEED air switch .... OFF

APU BLEED air switch ....ON

Engine No. 2 BLEED air switch .... OFF

-800 and MAX fleet

Trim Air Switch. ....ON

WING ANTI-ICE switch .... OFF

The WING ANTI-ICE switch must remain OFF until the engine BLEED air switches are repositioned to ON and the ISOLATION VALVE switch is repositioned to AUTO.

After Takeoff

Note: If engine failure occurs, do not position engine BLEED air switches ON until reaching 1500 feet or until obstacle clearance height has been attained.

After first flap retraction:

Engine No. 2 BLEED air switch ....ON

APU BLEED air switch .... OFF

When CABIN rate of CLIMB indicator stabilizes and workload permits at pilot's discretion:

Engine No. 1 BLEED air switch .... ON

ISOLATION VALVE switch .... AUTO

Landing

If additional go–around thrust is desired, configure for a "No Engine Bleed Landing."

When below 10,000 feet:

WING ANTI-ICE switch .... OFF

Right PACK switch .... AUTO

ISOLATION VALVE switch .... CLOSE

Left PACK switch .... AUTO

Engine No. 1 BLEED air switch .... OFF

APU BLEED air switch .... ON

Engine No. 2 BLEED air switch .... OFF

Supplementary Procedures — Chapter SP

Anti–Ice, Rain — Section 3

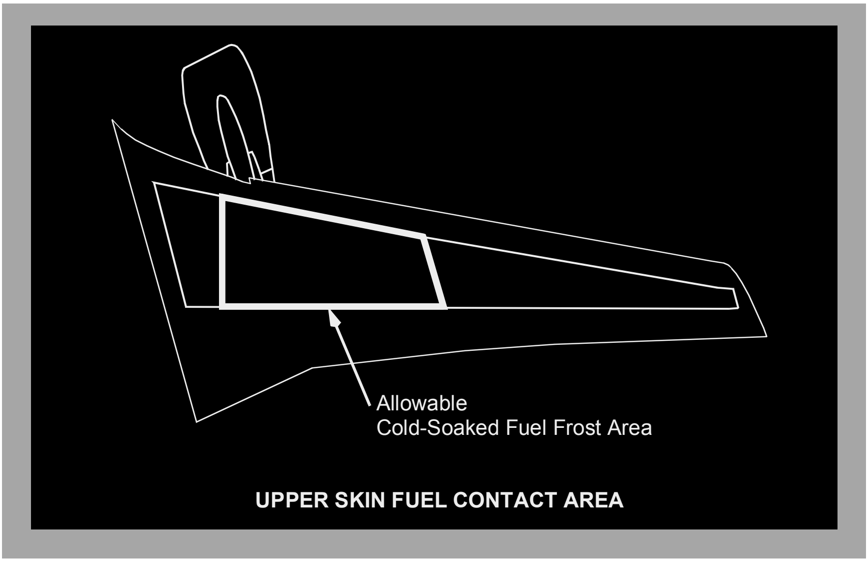
Anti–Ice Operation

Requirements for use of anti–ice and operational procedures for engine and wing anti–ice are contained in Supplementary Procedures, Adverse Weather Section SP.16.

Cold-Soaked Fuel Frost (CSFF)

Frost may form on the lower and upper wing surfaces due to cold-soaked fuel touching the wing surface after long flights with large fuel loads.

Exterior Safety Inspection - Airplanes with Defined Cold-Soaked Fuel Frost Area



Note: The presence of the painted cold soaked fuel frost area on the upper wing and the inclusion of these procedures in the FCOM do not constitute operational approval. Operators may be allowed to use these procedures by referring to the appropriate regulatory authority for approval or exemption, as required, to implement the procedure.

Surfaces .... Check

Visually inspect the lower and upper wing surfaces.

If there is frost or ice on the lower surface outboard of measuring stick 4, there may also be frost or ice on the upper surface. The distance that the frost extends outboard of measuring stick 4 can be used as an indication of the extent of the frost on the upper surface.

Takeoff with CSFF on lower wing surfaces is allowable provided all of the following conditions are met:

- Ambient air temperature is at or above +4°C, +39°F
- There is no precipitation or visible moisture (rain, snow, drizzle, or fog with less than 1 mile visibility)
- Tank fuel temperature is at or above -16°C, +3°F
- All leading edge devices, all control surfaces, tab surfaces, winglet surfaces, and control surface balance panel cavities must be free of snow, ice and frost.

If all of the above conditions are not met, takeoff with light coatings of frost, up to 1/8 inch (3 mm) in thickness, on lower wing surfaces due to cold fuel is allowable; however, all leading edge devices, all control surfaces, tab surfaces, winglet surfaces and control surface balance panel cavities must be free of snow, ice and frost. If the frost on the lower surface is greater than 1/8 inch (3 mm) in thickness, all snow, ice and frost on the wings must be removed using appropriate deicing/anti-icing procedures.

Takeoff with CSFF on upper wing surfaces is allowed provided all of the following conditions are met:

- The CSFF on the wing tank upper surfaces is only within the lines defining the permissible CSFF area with no snow, ice or frost on the leading edges or control surfaces
- Ambient air temperature is at or above +4°C, +39°F
- There is no precipitation or visible moisture (rain, snow, drizzle, or fog with less than 1 mile visibility)
- Tank fuel temperature is at or above -16°C, +3°F.

If all of the above conditions are not met, all snow, ice and frost on the upper wing surfaces must be removed using appropriate deicing/anti-icing procedures.

Exterior Safety Inspection - Airplanes without Defined Cold-Soaked Fuel Frost Area

Surfaces .... Check

Visually inspect the lower and upper wing surfaces.

If there is frost or ice on the lower surface outboard of measuring stick 4, there may also be frost or ice on the upper surface. The distance that the frost extends outboard of measuring stick 4 can be used as an indication of the extent of the frost on the upper surface.

Takeoff with CSFF on lower wing surfaces is allowable provided all the following condition are met::

- Ambient air temperature is at or above +4°C, +39°F
- There is no precipitation or visible moisture (rain, snow, drizzle, or fog with less than 1 mile visibility)
- Tank fuel temperature is at or above -16°C, or +3°F
- All leading edge devices, all control surfaces, tab surfaces, winglet surfaces, and control surface balance panel cavities must be free of snow, ice and frost.

If all of the above conditions are not met, takeoff with light coatings of frost, up to 1/8 inch (3 mm) in thickness, on lower wing surfaces due to cold fuel is allowable; however, all leading edge devices, all control surfaces, tab surfaces, winglet surfaces and control surface balance panel cavities must be free of snow, ice and frost. If the frost on the lower surface is greater than 1/8 inch (3 mm) in thickness, all snow, ice and frost on the wings must be removed using appropriate deicing/anti-icing procedures.

Takeoff with frost on upper wing surfaces due to cold fuel (CSFF) is not allowable. If any frost is present on the upper wing surface, all snow, ice and frost on the wings must be removed using appropriate deicing/anti-icing procedures.

Window Heat System Tests

Overheat Test

The overheat test simulates an overheat condition to check the overheat warning function of the window heat system.

WINDOW HEAT switches .... ON

WINDOW HEAT TEST switch .... OVHT

OVERHEAT lights – On

ON lights – Extinguish

Lights extinguish after approximately 1 minute.

MASTER CAUTION – On

ANTI–ICE system annunciator – On

WINDOW HEAT switches .... Reset

Position the WINDOW HEAT switches OFF, then ON.

Power Test

The power test verifies operation of the window heat system. The test may be accomplished when any of the window heat ON lights are extinguished and the associated WINDOW HEAT switch is ON.

WINDOW HEAT switches .... ON

Note: Do not perform the power test when all ON lights are illuminated

WINDOW HEAT TEST switch .... PWR

The controller is forced to full power, bypassing normal temperature control. Overheat protection is still available.

WINDOW HEAT ON lights ....Illuminated

If any ON light remains extinguished, the window heat system is inoperative. Observe the maximum airspeed limit of 250 kts below 10,000 feet.

Level Change Climb/Descent

ALTITUDE selector .... Set desired altitude

Note: If a new MCP altitude is selected while in ALT ACQ, the AFDS engages in V/S and the existing vertical speed is maintained.

LVL CHG switch .... Push

Verify FMA display:

Thrust mode (climb) – N1

Thrust mode (descent) – RETARD then ARM

Pitch mode – MCP SPD

IAS/MACH Selector .... Set desired speed

Vertical Speed (V/S) Climb/Descent

ALTITUDE selector .... Set desired altitude

Note: If a new MCP altitude is selected while in ALT ACQ, the AFDS engages in V/S and the existing vertical speed is maintained.

V/S thumbwheel .... Set desired vertical speed

Verify FMA display:

Thrust mode (climb or descent) – MCP SPD

Pitch mode – V/S

IAS/MACH Selector .... Set desired speed

To transition to the vertical speed mode from another engaged climb or descent mode:

V/S mode switch .... Push

V/S climb mode engages at existing V/S.

V/S thumbwheel .... Set desired vertical speed

Verify FMA display:

Thrust mode (climb or descent) – MCP SPD

Pitch mode – V/S

IAS/MACH Selector .... Set desired speed

Intervention of FMC Altitude Constraints during VNAV Climb

MCP altitude selector .... Set new altitude

New altitude must be higher than the FMC altitude constraint(s) to be deleted.

ALT INTV switch .... Push

Each push of the ALT INTV switch will delete an FMC altitude constraint.

Intervention of FMC Cruise Altitude during VNAV Cruise

MCP altitude selector ....Set

ALT INTV switch .... Push

If a higher altitude is selected, a CRZ climb will be started.

If the airplane is more than 50 nm from T/D, if a lower altitude is selected, a CRZ descent will be started if the selected altitude is at or above any FMC altitude constraint.

If the airplane is more than 50 nm from T/D, if a lower altitude is selected, an early descent will be started if the selected altitude is below any FMC altitude constraint.

If the airplane is 50 nm or less from T/D, if a lower altitude is selected, an early descent will be started.

Intervention of FMC Altitude Constraints during VNAV Descent

MCP altitude selector .... Set new altitude

New altitude must be lower than the FMC altitude constraint (s) to be deleted.

ALT INTV switch .... Push

Each push of the ALT INTV switch will delete an FMC altitude constraint.

If all FMC altitude constraints are deleted, the descent mode will revert to a VNAV speed descent.

Intervention of FMC Airspeed Constraints during VNAV

SPD INTV switch .... Push

MCP IAS/MACH display shows current FMC target speed.

IAS/MACH Selector .... Set desired speed

VNAV remains engaged.

To resume former FMC speed:

SPD INTV switch .... Push

MCP IAS/MACH display blanks and FMC commanded VNAV speed is active.

Altitude Hold

Altitude HOLD switch .... Push

Verify FMA display:

Pitch mode – ALT HOLD

Heading Select

Heading selector .... Set desired heading

Heading select switch .... Push

Verify FMA display:

Roll mode – HDG SEL

VOR Navigation

VHF NAV radio(s) .... Tune and Identify

COURSE selector .... Set desired course

When on an intercept heading to the VOR course:

VOR LOC mode switch .... Push

Verify VOR LOC armed mode annunciates.

A/P automatically captures the VOR course.

Verify VOR LOC engaged mode annunciates upon course capture.

Note: If change to a localizer frequency is desired when captured in the VOR mode, disengage VOR LOC mode prior to selection of the localizer. VOR LOC mode can then be reengaged.

Instrument Approach using Vertical Speed (V/S)

Pilot Flying	Pilot Monitoring

Initially
• If on radar vectors
  • HDG SEL
  • Pitch mode (as needed)
• If enroute to a fix
  • LNAV or other roll mode
  • VNAV or other pitch mode	

Call "FLAPS ___" according to the flap extension schedule.	Set the flap lever as directed. Monitor flaps and slats extension.

Note: If required to remain at or above MDA(H) during the missed approach, the missed approach must be initiated at least 50 feet above MDA(H).

Recommended roll modes:

- RNAV, GPS, TACAN, LOC-BC, VOR or NDB approach: LNAV or HDG SEL.
- LOC, SDF or LDA approach: VOR/LOC or LNAV.

Note: When using LNAV to intercept a localizer, LNAV might parallel the localizer without capturing it. Use HDG SEL to intercept the final approach course, if needed.

Ensure appropriate navaids (VOR, LOC or NDB) are tuned and identified before commencing the approach.

Pilot Flying	Pilot Monitoring
Use LNAV or other roll mode to intercept the final approach course as needed.	
Approximately 2 NM before the final approach fix, set the first intermediate altitude constraint or MDA(H). Set the MCP altitude to the nearest 100 foot increment at or above each intermediate altitude constraint or MDA(H). When the current constraint is assured, set the next constraint before ALT HOLD is engaged to achieve a continuous descent path.	Approximately 2 NM before the final approach fix, call “APPROACHING GLIDE PATH.”
Call: • “GEAR DOWN” • “FLAPS 15.”	Set the landing gear lever to DN. Verify that the green landing gear indicator lights are illuminated. Set the flap lever to 15. Set the engine start switches to CONT.
Set the speed brake lever to ARM. Verify that the SPEED BRAKE ARMED light is illuminated.	

Before descent to MDA(H):

Pilot Flying	Pilot Monitoring
Call "FLAPS ___" as needed for landing.	Set the flap lever as directed.

At descent point:

Desired V/S .... Set

Set desired V/S to descend to MDA(H). Use a V/S that results in no level flight segment at MDA(H).

Verify V/S mode annunciates.

Pilot Flying	Pilot Monitoring
Call "LANDING CHECKLIST."	Do the LANDING checklist.

At the final approach fix, crosscheck the altimeters. Verify they agree within 100 feet.

Approximately 300 feet above MDA(H):

MCP altitude .... Set missed approach altitude

At MDA(H)/missed approach point:

If suitable visual reference is not established, execute missed approach.

After suitable visual reference is established:

A/P disengage switch ....Push

Disengage the autopilot in accordance with regulatory requirements.

A/T disengage switch ....Push

Disengage the autothrottle when disengaging the autopilot.

Circling Approach

If a missed approach is needed at any time while circling, make an initial climbing turn toward the landing runway and intercept the missed approach course.

Configuration at MDA(H):

- Gear down
- Flaps 15
- Speedbrake armed

MCP altitude selector .... Set

Set the MCP altitude to the nearest 100 foot increment at or above the MDA(H).

Accomplish an instrument approach, establish suitable visual reference and level off at MCP altitude.

Verify ALT HLD or VNAV ALT mode annunciates.

ALT HLD mode .... Verify/select

Verify ALT HLD mode annunciates.

MCP altitude selector .... Set missed approach altitude

HDG SEL switch .... Push

Verify HDG SEL mode annunciates.

Before starting the turn to base:

- Landing flaps (if not previously selected)
- Do the LANDING checklist.

Intercepting the landing profile:

Autopilot disengage switch .... Push

Autothrottle disengage switch .... Push

Instrument Approach - RNAV (RNP) AR

Note: Operators need approval to conduct RNAV (RNP) AR Instrument Approaches.

Note: For RNAV (GPS) and RNAV (GNSS) procedures use the Landing Procedure - Instrument Approach using VNAV in Normal Procedures.

Note: This procedure is not authorized using QFE.

The procedure below supplements Normal Preflight, Cruise, Descent and Approach Procedures and replaces the Landing Procedure.

Additional information is given in case of a go-around.

Preflight Procedure

Review RNP availability predictions.

Pre-approach Requirements

Airplane equipment required to begin the approach:

- EGPWS
- 2 FMCs
- 2 CDUs
- 2 GPS Receivers
- 2 Radio Altimeters
- 2 ADIRUs, IRSs in NAV mode
- 2 EFIS/MAP or PFD/ND displays (as installed)
- 1 A/P and 2 F/Ds capable of LNAV and VNAV(for RNP 0.15 or greater)
- 2 A/P and 2 F/Ds capable of LNAV and VNAV(for RNP less than 0.15)

Note: Do the Go-Around and Missed Approach Procedure if the UNABLE REQD NAV PERF-RNP, FMC DISAGREE, or any VERIFY POS alerting message is shown unless suitable visual reference is established and maintained.

WARNING: If an UNABLE REQD NAV PERF-RNP is shown during the approach, whether the lateral or vertical RNP are exceeded or not, do the Go-Around and Missed Approach Procedure unless suitable visual reference is established and maintained.

Do the following before starting the approach

- verify that the UNABLE REQD NAV PERF-RNP alert is not displayed
- verify that the approach RNP is equal to or greater than:
  - 0.10 (A/P or F/D)
- set current local altimeter (remote altimeter settings not allowed)
- verify that the wind is within limits published for the approach (if applicable)
- verify that the reported airport temperature is within published limits for the approach
- review the maximum IAS for each segment of the approach as determined by aircraft category and applicable regulatory airspeed requirements.

Cruise Procedure

Pilot Flying	Pilot Monitoring
	When selecting the approach from the navigation database verify ACT RTE X LEGS page matches the charted approach. If there is an “at or above” altitude restriction before the FAF, it may be changed to an “at” altitude restriction using the same altitude. Speed modifications are allowed as long as the maximum published speed is not exceeded.

Descent Procedure

Pilot Flying	Pilot Monitoring
In the approach briefing include speed and altitude restrictions, missed approach, engine failure, and unable RNP procedures.	Select VOR UPDATE - OFF on the NAV OPTIONS page. Inhibit other navaids as needed per NOTAM.

Approach Procedure

Complete the Approach Procedure before the initial approach fix, or the start of radar vectors to the final approach course.

Note: When receiving radar vectors from ATC, intercept course modifications may be used to join the LNAV path at any point on the initial, intermediate or missed approach segments.

Note: Direct To modifications are not permitted when:

- The fix is the beginning of an RF leg
- The fix is the Final Approach Fix (FAF) for the procedure.

Pilot Flying	Pilot Monitoring
	On the RNP PROGRESS page verify RNP for the approach.

Note: For airplanes with NPS, verify that the vertical RNP is 125 feet. While there are no vertical RNP values published on the approach chart, the use of 125 feet will cause the NPS amber deviation exceedance alert to occur at 75 feet or slightly less deviation, since vertical ANP will be at least 50 feet at all times.

Landing Procedure

Pilot Flying	Pilot Monitoring

Initially
• If on radar vectors
  • HDG SEL
  • Pitch mode (as needed)
• If enroute to a fix
  • LNAV or other roll mode
  • VNAV or other pitch mode	

	Notify the cabin crew to prepare for landing. Verify that the cabin is secure.

<table>
<tr><th>Pilot Flying</th><th>Pilot Monitoring</th></tr>
<tr><td>Select TERR on map.

Select CDU: ACT RTE X LEGS page.</td><td>Select TERR or WX radar on map.</td></tr>
<tr><td colspan="2">Use LNAV and VNAV or other pitch mode for initial descent. VNAV is required from the FAF inbound.

Some approach procedures can require use of VNAV from the IAF inbound.

On intercept heading, select or verify LNAV.</td></tr>
<tr><td>Call “FLAPS ___” according to the flap extension schedule or approach speed constraint.</td><td>Set the flap lever as directed. Monitor flaps and slats extension.</td></tr>
<tr><td>Approximately 2 NM before the final approach fix and after ALT HOLD or VNAV PTH or VNAV ALT (as installed) is annunciated:
• set DA(H) on the MCP
• select or verify VNAV
• select or verify speed intervention (as installed)</td><td></td></tr>
<tr><td colspan="2">Maximum Lateral Deviation (XTK ERROR): NPS amber indication or 1 x RNP

Maximum Vertical Deviation - FAF to DA: 75 feet

Monitor NPS</td></tr>
<tr><td>Approaching glide path, call:
• “GEAR DOWN”
• “FLAPS 15”</td><td>Set the landing gear lever to DN.

Verify that the green landing gear indicator lights are illuminated.

Set the flap lever to 15.

Set the engine start switches to CONT.</td></tr>
<tr><td>Set the speed brake lever to ARM.

Verify that the SPEED BRAKE ARMED light is illuminated.</td><td></td></tr>
<tr><td>Beginning the final approach descent, call “FLAPS ___” as needed for landing.</td><td>Set the flap lever as directed.</td></tr>
<tr><td>Call “LANDING CHECKLIST.”</td><td>Do the LANDING checklist.</td></tr>
<tr><td>When at least 300 feet below the missed approach altitude, set the missed approach altitude on the MCP.</td><td></td></tr>
</table>

Pilot Flying	Pilot Monitoring
At the final approach fix, verify the crossing altitude and crosscheck altimeters within 100 feet between primary altimeters.	
Monitor the approach.	
If suitable visual reference is established at DA(H), disengage the autopilot in accordance with regulatory requirements, and disengage the autothrottle at the same time. Maintain the glide path to landing.	

Intentionally
Blank

Aircraft Communication Addressing and Reporting System (ACARS)

The following procedures are applicable to the noted ACARS functions from the company pages.

Pre-Departure Clearance

The flight crew shall manually verify (compare) the filed flight plan versus the digital pre-departure clearance and shall initiate voice contact with Air Traffic Control if any question/confusion exists between the filed flight plan and the digital pre-departure clearance.

Digital-Automatic Information Service

The flight crew shall verify that the D-ATIS altimeter setting numeric value and alpha value are identical. If the D-ATIS altimeter setting numeric value and alpha values are different, the flight crew must not accept the D-ATIS altimeter setting.

Oceanic Clearances

The flight crew shall manually verify (compare) the filed flight plan versus the digital oceanic clearance and initiate voice contact with Air Traffic Control if any questions/confusion exists between the filed flight plan and the digital oceanic clearance.

Weight and Balance

The flight crew shall verify the Weight and Balance numeric and alphabetical values are identical. If the Weight and Balance numeric and alphabetical values are different, the flight crew must not accept the Weight and Balance data.

Takeoff Data

The flight crew shall verify the Takeoff Data numeric and alphabetic values are identical. If the Takeoff Data numeric and alphabetic values are different, the flight crew must not accept the Takeoff Data message.

Cockpit Voice Recorder Test

Note: The Cockpit VOICE RECORDER switch must be in the ON position or at least one engine must be operating to perform this test.

Test switch .... Push

Hold switch for 5 seconds. Observe that the STATUS light flashes once. A tone may be heard through a headset plugged into the headset jack.

#Electrical Power Up

The following procedure is accomplished to permit safe application of electrical power.

BATTERY switch .... Guard closed

Note: Do not move the airplane until Integrated Standby Flight Display (ISFD) alignment is complete.

STANDBY POWER switch .... Guard closed

ALTERNATE FLAPS master switch .... Guard closed

Windshield WIPER selector(s) .... PARK

ELECTRIC HYDRAULIC PUMPS switches .... OFF

LANDING GEAR lever ....DN

Verify that the green landing gear indicator lights are illuminated.

Verify that the red landing gear indicator lights are extinguished.

If external power is needed:

Verify that the GRD POWER AVAILABLE light is illuminated.

GRD POWER switch – ON

Verify that the SOURCE OFF lights are extinguished.

Verify that the TRANSFER BUS OFF lights are extinguished.

Verify that the STANDBY PWR OFF light is extinguished.

If APU power is needed:

Verify that the engine No. 1, APU and the engine No. 2 fire switches are in.

Alert ground personnel before the following test is accomplished.

OVERHEAT DETECTOR switches – NORMAL

TEST switch – Hold to FAULT/INOP

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Verify that the FAULT light is illuminated.

If the FAULT light fails to illuminate, the fault monitoring system is inoperative.

Verify that the APU DET INOP light is illuminated.

Do not operate the APU if the APU DET INOP light fails to illuminate.

TEST switch – Hold to OVHT/FIRE

Verify that the fire warning bell sounds.

Verify that the master FIRE WARN lights are illuminated.

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Master FIRE WARN light – Push

Verify that the master FIRE WARN lights are extinguished.

Verify that the fire warning bell cancels.

Verify that the engine No. 1, APU and the engine No. 2 fire switches stay illuminated.

Verify that the ENG 1 OVERHEAT and ENG 2 OVERHEAT lights stay illuminated.

Note: The WHEEL WELL fire warning light on the overheat and fire protection panel may or may not illuminate when testing on DC electrical power only. For accurate testing, do the wheel well fire detection system test after AC electrical power is established.

EXTINGUISHER TEST switch – Check

TEST Switch - Position to 1 and hold

Verify that the three green extinguisher test lights are illuminated.

TEST Switch - Release

Verify that the three green extinguisher test lights are extinguished.

Repeat for test position 2.

APU - Start

Note: If extended APU operation is needed on the ground and the airplane busses are powered by AC electrical power, position an AC powered fuel pump ON. This will extend the service life of the APU fuel control unit.

Note: If fuel is loaded in the center tank, position the left center tank fuel pump switch ON to prevent a fuel imbalance before takeoff.

CAUTION: Center tank fuel pump switches should be positioned ON only if the fuel quantity in the center tank exceeds 453 kgs.

CAUTION: Do not operate the center tank fuel pumps with the flight deck unattended.

When the APU GEN OFF BUS light is illuminated:

APU GENERATOR bus switches - ON

Verify that the SOURCE OFF lights are extinguished.

Verify that the TRANSFER BUS OFF lights are extinguished.

Verify that the STANDBY PWR OFF light is extinguished.

-Non MAX Fleet

Verify that the APU MAINT light is extinguished.

-MAX Fleet

Verify that the APU DOOR light is extinguished.

Verify that the APU LOW OIL PRESSURE light is extinguished.

Verify that the APU FAULT light is extinguished.

Verify that the APU OVERSPEED light is extinguished.

Wheel well fire detection system.. Test

Test switch – Hold to OVHT/FIRE

Verify fire warning bell sounds, master FIRE WARN lights, MASTER CAUTION lights and OVHT/DET annunciator illuminate.

Fire warning BELL CUTOUT switch – Push

Verify that the master FIRE WARN lights extinguish.

Verify that the fire warning bell cancels.

Verify that the WHEEL WELL fire warning light is illuminated.

#Electrical Power Down

This procedure assumes the Secure procedure is complete.

APU switch and/or GRD POWER switch ....OFF

If APU was operating:

Delay approximately 2 minutes after the APU GEN OFF BUS light extinguishes before placing the BATTERY switch OFF.

BATTERY switch ....OFF

Standby Power Test

Battery switch ....ON

AC and DC meter selectors .... STBY PWR

If APU generator is on–line:

APU GEN No. 1 switch ....OFF

APU GEN No. 2 switch ....OFF

If ground power is on–line:

GRD PWR switch ....OFF

STANDBY POWER switch ....OFF

Check STANDBY PWR OFF light illuminated.

AC–DC voltmeters ....Zero

STANDBY POWER switch ....BAT

Check STANDBY PWR OFF Light extinguished.

AC–DC voltmeters ....Check

AC voltmeter 115 +/-5 volts

DC voltmeter 24 +/-4 volts

Frequency meter ....Check

Check frequency meter for normal indication: 400 +/- 5 CPS.

DC meter selector .... BAT

Check DC voltmeter for normal indication: 24 +/- 2 volts.

Check DC ammeter for discharge indication: a negative value.

DC meter selector .... AUX BAT

Check DC voltmeter for normal indication: 24 +/- 2 volts.

Check DC ammeter for discharge indication: a negative value.

STANDBY POWER switch ....AUTO

GRD PWR switch or APU GEN No. 1 and No. 2 switches ....ON

Note: It can take up to 3 minutes for CDS displays to recover when power is interrupted for more than 2 seconds on the ground.

Intentionally
Blank

Battery Start

(With APU bleed or ground air available)

Maintenance documents .... Check

FLIGHT DECK ACCESS SYSTEM switch .... Guard closed

BATTERY switch .... Guard closed

ELECTRIC HYDRAULIC PUMPS switches .... OFF

LANDING GEAR lever .... DN

Verify that the green landing gear indicator lights are illuminated.

Verify that the red landing gear indicator lights are extinguished.

Emergency equipment .... Check

Fire extinguisher - Checked and stowed

Crash axe - Stowed

Escape ropes - Stowed

Other needed equipment - Checked and stowed.

Flight recorder switch .... Guard closed

Circuit breakers (P6 panel) .... Check

Circuit breakers (control stand, P18 panel) .... Check

Accomplish the Interior and Exterior Inspection if required, except for items requiring electrical or hydraulic power.

Verify that the oxygen pressure is sufficient for flight.

Accomplish the following Preflight Procedure - First Officer items:

Overheat and fire protection panel .... Check

OVERHEAT DETECTOR switches - NORMAL

TEST switch - Hold to FAULT/INOP

TEST switch - Hold to OVHT/FIRE

EXTINGUISHER TEST switch - Check

APU switch
(bleed air source, if available) .... START

On the captain's command, the first officer reads and the captain does the following items:

Oxygen .... Test and set

CAB/UTIL power switch (as installed) .... ON

IFE/PASS seat power switch (as installed) .... ON

GALLEY power switch (as installed) .... ON

EMERGENCY EXIT LIGHTS switch .... Guard closed

Passenger signs .... Set

HYDRAULIC PUMP switches .... ON

Air conditioning panel .... Set

PACK switches - AUTO or HIGH

Engine BLEED air switches - ON

APU BLEED air switch - ON

SPEED BRAKE lever .... DOWN detent

Reverse thrust levers .... Down

Forward thrust levers .... Closed

Parking brake .... Set

Note: The wheels should be chocked in case the brake pressure has bled down.

Engine start levers .... CUTOFF

Papers .... Aboard

When cleared for Engine Start, do the following:

Air conditioning PACK switches .... OFF

ANTICOLLISION light switch .... ON

Ignition select switch .... IGN-R

Engine Start

Engine No. 1 start .... Accomplish

Only N1, N2, and oil quantity are displayed until the EECs are powered.

Generator 1 switch ....ON

IRS mode selectors .... OFF, then NAV

Verify that the ON DC lights illuminate, then extinguish

Verify that the ALIGN lights are illuminated.

FMC/CDU .... Set IRS position

Verify that the following are sufficient for flight:

- hydraulic quantity
- engine oil quantity

WARNING: If engine No. 1 was started using a ground air source, to minimize the hazard to ground personnel, the external air should be disconnected and engine No. 2 started using the Engine Crossbleed Start procedure.

Engine No. 2 start .... Accomplish

Generator 2 switch ....ON

Cabin pressurization panel .... Set

FLIGHT ALTITUDE indicator - Cruise altitude

LANDING ALTITUDE indicator - Destination field elevation

Pressurization mode selector - AUTO

Verify that the ALTN light is extinguished.

Verify that the MANUAL light is extinguished.

Complete the Preliminary Preflight Procedure - Captain or First Officer by doing the following items:

PSEU light .... Verify extinguished

GPS light .... Verify extinguished

ILS light... Verify extinguished

GLS light .... Verify extinguished

SERVICE INTERPHONE switch .... OFF

ENGINE panel ....Set

Verify that the REVERSER lights are extinguished

Verify that the ENGINE CONTROL lights are extinguished

EEC switches - ALTN then ON

Oxygen panel ....Set

CREW OXYGEN pressure indicator - Check

Verify that the pressure meets dispatch requirements.

Note: PASSENGER OXYGEN switch activation causes deployment of the passenger oxygen masks.

PASSENGER OXYGEN switch - Guard closed

Verify that the PASS OXY ON light is extinguished.

Landing gear indicator lights ....Verify illuminated

Emergency EVACUATION activation switch (as installed) ....Guard closed

Verify that the EVAC light is extinguished

Manual gear extension access door ....Closed

Accomplish the normal CDU Preflight Procedure - Captain and First Officer, Preflight Procedure - First Officer, Preflight Procedure - Captain, Before Start Procedure and Before Taxi Procedure to ensure that the flight deck preparation is complete.

BEFORE TAXI checklist..Accomplish

IRS alignment .... Complete

The airplane is ready for taxi. Refer to the normal checklists for subsequent checks.

Engine Start with Ground Air Source - LPU (AC electrical power available)

Engine No. 1 must be started first.

When cleared to start:

APU BLEED air switch ....OFF

Engine No. 1 start ....Accomplish

Use normal start procedures.

WARNING: To minimize the hazard to ground personnel, the external air should be disconnected, and engine No. 2 started using the Engine Crossbleed Start procedure.

#Engine Crossbleed Start

Do not accomplish a crossbleed start during pushback.

Before using this procedure, ensure that the area to the rear is clear.

Engine BLEED air switches .... ON

APU BLEED air switch ....OFF

PACK switches ....OFF

ISOLATION VALVE switch .... AUTO

Ensures bleed air supply for engine start.

Engine thrust lever
(operating engine) ....Advance thrust lever

Advance thrust lever until bleed duct pressure indicates 30 PSI.

Non–operating engine ....Start

Use normal start procedures with crossbleed air.

After starter cutout, adjust thrust on both engines, as required.

Setting N1 Bugs with No Operative FMC (Manual N1 Bug Setting)

Reference the Performance – Inflight section to determine N1 setting for desired phase of flight.

N1 SET outer knob .... BOTH

The last FMC computed value is displayed by reference N1 bugs and readouts. If the FMC has not calculated an input since power up, a default value of 104% is displayed.

N1 SET inner knob .... Set N1

Note: If the N1 SET outer knob is returned to the AUTO position, the bugs and readouts will revert to the last FMC computed value or 104% if the FMC has not calculated an input since power up.

High Altitude Airport Engine Start (Above 8400 Feet)

Engine start .... Accomplish

An indication of N1 rotation plus maximum motoring and a minimum of 20% N2 are required prior to introducing fuel to the engine.

Note: Maximum motoring occurs when N2 acceleration is less than 1% in approximately 5 seconds.

Intentionally
Blank

Fire and Overheat System Test with an Inoperative Loop

To determine the specific inoperative loop:

OVHT DET switches... A

Test switch .... OVHT/FIRE

If the FAULT light stays extinguished and both ENG OVERHEAT lights and engine fire switches illuminate, loop A is good.

If the FAULT light illuminates and the ENG OVERHEAT light and engine fire switch for an engine stay extinguished, there is a fault in loop A of the detection system for that engine.

OVHT DET switches..B

Test switch .... OVHT/FIRE

If the FAULT light stays extinguished and both ENG OVERHEAT lights and engine fire switches illuminate, loop B is good.

If the FAULT light illuminates and the ENG OVERHEAT light and engine fire switch for an engine extinguished, there is a fault in loop B of the detection system for that engine.

OVHT DET switches..As required

Select the good loop for each engine (NORMAL if both loops tested good).

Test switch .... OVHT/FIRE

If the test is successful leave the fire panel in this configuration for flight.

Intentionally
Blank

Altimeter Difference

Note: If flight in RVSM airspace is planned use the RVSM table in the limitations section.

This procedure is accomplished when there is a noticeable difference between the altimeters. Accomplish this procedure in stabilized level flight or on the ground.

Altimeter barometric settings .... Check

Check all altimeters set to proper barometric setting for phase of flight.

Standby altimeter baro set control .... Rotate and reset

Rotate to a different setting, then reset proper barometric setting.

Altimeters .... Crosscheck

Maximum differences between the altimeter readings:

Altitude	CDS/CDS	CDS/Standby
Sea Level	50 feet	60 feet
5,000 feet	50 feet	80 feet
10,000 feet	60 feet	120 feet
15,000 feet	70 feet	(see note)
20,000 feet	80 feet	(see note)
25,000 feet	100 feet	(see note)
30,000 feet	120 feet	(see note)
35,000 feet	140 feet	(see note)
40,000 feet	160 feet	(see note)
41,000 feet	170 feet	(see note)

Note: Above 10,000 feet and 0.4 Mach, position error causes the tolerance to diverge rapidly and direct crosscheck becomes inconclusive. Between 10,000 feet and 29,000 feet, differences greater than 400 feet should be suspect and verified by ground maintenance checks. Between 29,000 feet and the maximum operating altitude, differences greater than 500 feet should be suspect and verified by ground maintenance checks.

If it is not possible to identify which altimeter is indicating the correct altitude:

ATC .... Notify

Setting Airspeed Bugs with No Operative FMC (Manual Airspeed Bug Setting)

To set reference airspeed bugs for takeoff:

Speed reference selector (outer) V1

Default speed of 80 knots is displayed.

Speed reference selector (inner) .... Set V1 speed

V1 bug is displayed when a speed greater than 80 knots is set. The NO VSPD flag is displayed until both V1 and VR are set.

Speed reference selector (outer) .... VR

Default speed of 80 knots is displayed.

Speed reference selector (inner) .... Set VR speed

VR bug is displayed when a speed greater than 80 knots is set. The NO VSPD flag is removed after both V1 and VR are set.

MCP speed selector .... Set V2

Airspeed cursor and V2+15 bug move to the correct speeds.

Speed reference selector (outer) .... WT

Default weight of 32,000 kgs is displayed.

Speed reference selector (inner) .... Set takeoff gross weight

Flaps up maneuver speed bug is displayed.

Note: If VREF is selected on the ground, INVALID ENTRY is displayed.

To set the spare bug, if desired:

Speed Reference selector (outer) .... Spare bug

Default speed of 60 knots is displayed.

Speed reference selector (inner) .... Set

Set speed as desired.

Speed reference selector (outer) .... SET

Digital readout is removed.

Note: When the flap lever is set to any takeoff flap setting above flaps 1, a bug comes into view for the next smaller flap maneuvering speed, between takeoff flaps and flaps up. For example, if the flap lever is set to 15 for takeoff, a bug for flaps 5 maneuvering speed will appear. For a flaps 1 takeoff, the flaps 1 maneuvering speed will be displayed.

To set reference airspeed bugs for approach:

Speed reference selector (outer) ....WT

Default weight of 32,000 kgs is displayed.

Speed reference selector (inner) .... Set current gross weight

Flaps up maneuver speed bug is displayed.

Speed reference selector (outer) ....VREF

Default speed of 80 knots is displayed.

Speed reference selector (inner) ....Set VREF speed

The green VREF bug and white VREF +15 (+20 for -800 fleet) bug are shown when a speed greater than 80 knots is set.

Note: If V1 or VR is selected in flight, INVALID ENTRY is displayed.

To set the spare bug, if desired:

Speed reference selector (outer) .... Spare bug

Default speed of 60 knots is displayed.

Speed reference selector (inner) .... Set

Set speed as desired.

Speed reference selector (outer) ....SET

Digital readout is removed.

Tests

Transponder Test

This procedure requires the IRSs to be aligned and in NAV mode.

Transponder reply selector..ON or AUTO

Transponder .... TEST

Check FAIL light illuminates.

Check all code segments illuminate. Verify no error codes exist.

Verify aural indicates TCAS system test passed.

Note: TCAS TEST is displayed on the navigation display during the test followed by TCAS TEST PASSED or TCAS TEST FAILED. This test remains in view for 8 seconds then blanks. An aural annunciation sounds at the completion of the test.

AURAL ALERTS	DEFINITION
“TCAS TEST” “TCAS TEST FAIL”	Test failed. Maintenance required.
“TCAS TEST” “TCAS TEST OK”	Test complete. System operable.

Weather Radar Test

EFIS mode selector.............................. MAP, MAP CTR, VOR, or APP

Weather Radar Mode .... TEST

STAB (as installed)..ON

WXR (EFIS control panel) ....ON

Verify test pattern consisting of the following colors appears:

- Green
- Amber
- Red
- Magenta.

If testing of the PWS system is desired:

Weather Radar Mode .... Deselect TEST

WXR (EFIS control panel) .... ON

Weather Radar Mode .... TEST

Verify the amber WINDSHEAR caution, red WINDSHEAR warning and PWS FAIL annunciations display momentarily and then extinguish.

Note: In the short time the weather radar is on and not in the TEST position, it will radiate.

IRS

Align Light(s) Flashing

Do not move IRS Mode selector to OFF except where called for in procedure.

POS INIT page .... Select

Set IRS position .... Enter present position

Enter present position using the most accurate latitude and longitude available. If the present position is being entered via the CDU and a position is already displayed on the SET IRS POS line, enter new position over displayed position.

If ALIGN light continues to flash:

Set IRS position .... Enter present position

Re-enter same present position.

If ALIGN light continues to flash after re-entry:

IRS ....OFF

Rotate IRS Mode Selector to OFF and verify ALIGN light extinguished.

Note: Light must be extinguished before continuing with procedure (approximately 30 seconds.)

IRS ....NAV

Rotate IRS Mode Selector to NAV and verify ALIGN light illuminated.

Set IRS position .... Enter present position

Enter present position. If ALIGN light flashes, re-enter same present position over displayed position.

Note: Approximately five to seventeen minutes are required for alignment.

If ALIGN light continues to flash, maintenance action is required.

Fast Realignment

Prior to commencing procedure the airplane must be parked and not moved until procedure is complete and ALIGN lights extinguish.

IRS mode selectors .... ALIGN

Observe ALIGN lights illuminate steadily.

CDU .... Set

Enter present position on SET IRS POS line of the POS INIT page.

IRS mode selector .... NAV

Observe ALIGN light extinguished within 30 seconds.

Note: If time permits it is preferable to perform a full alignment of the IRS. A more precise alignment will result.

Note: If the mode selector is accidentally switched to OFF or ATT, position mode selector to OFF, wait for ALIGN light(s) to extinguish, then perform full alignment procedure.

Inadvertent Selection of Attitude Mode (while on the ground)

Inadvertent selection of the attitude mode may be due to physically overpowering the switch during turn–on or may be the result of a faulty switch which prevents the flight crew from accurately determining which mode is selected.

If ATT position is selected inadvertently when switching to NAV

IRS mode selectors .... OFF

Observe ALIGN lights extinguish.

After ALIGN lights extinguish, initiate a full alignment.

IRS Entries

Present Position Entry

IRS mode selector .... NAV

ALIGN lights must be illuminated (steady or flashing).

IRS display selector .... PPOS

Latitude ....Enter

Key–in latitude in the data display, beginning with N or S, then press the ENT Key (the Cue Lights extinguish).

Longitude ....Enter

Key–in longitude in the data display, beginning with E or W, then press the ENT key (the cue lights extinguish). Observe that proper latitude and longitude are displayed and that the ALIGN light is not flashing.

Heading – Enter through CDU

FMC/CDU POS INIT page .... Select

Enter the correct heading into the CDU scratch pad then press line select key 5R. Verify entered heading appears on line 5R. Select HDG on the IRS display selector and verify that the entered heading is displayed on the navigation displays.

Heading – Enter through ISDU

IRS display selector ....HDG

Press the H key to initiate a heading entry.

Key–in present magnetic heading. Press the ENT key (the cue lights extinguish). Observe proper heading displayed on the navigation displays.

Lateral Navigation (LNAV)

Proceeding Direct to a Waypoint (overwrite)

RTE LEGS page .... Select

On page 1/XX, line 1L, enter desired waypoint over the presently active waypoint.

Correct any ROUTE DISCONTINUITY if entered waypoint was not in original flight plan.

If abeam waypoints are desired:

ABEAM PTS key (as installed) .... Push

EXEC key .... Push

Observe the MOD RTE LEGS page changes to ACT.

Proceeding Direct to a Waypoint (DIR/INTC)

DIR INTC key .... Push

Observe DIRECT TO box prompts displayed in line 6L.

Enter desired waypoint on the DIRECT TO line. Observe the waypoint automatically transfers to line 1L.

Correct any ROUTE DISCONTINUITY if entered waypoint was not in the original flight plan.

EXEC key .... Push

Observe MOD RTE LEGS page changes to ACT.

Intercepting a Leg (Course) to a Waypoint

RTE LEGS page .... Select

On page 1/XX, line 1L, enter desired waypoint over presently active waypoint.

Observe INTC CRS prompt displayed in line 6R.

Enter the desired intercept course in the INTC CRS line. Observe the desired course is displayed on line 6R. The displayed course on line 1L may vary by several degrees due to magnetic variation.

Correct any ROUTE DISCONTINUITY if the entered waypoint was not in original flight plan.

EXEC key .... Push

Observe MOD RTE LEGS page changes to ACT.

LNAV may disengage after execution of an intercept leg to a waypoint. If LNAV disengages, turn to a heading to satisfy LNAV capture criteria, as described in Chapter 11, and then engage LNAV.

Intercepting a Leg (Course) to a Waypoint (DIR/INTC)

DIR INTC key .... Push

Observe INTC LEG TO box prompts displayed in line 6R.

Enter the desired waypoint on the INTC LEG TO line. Observe the waypoint automatically transfers to line 1L.

Enter the desired intercept course in the INTC CRS line. Observe the desired course is displayed on line 6R. The displayed course on line 1L may vary by several degrees due to magnetic variation.

Correct any ROUTE DISCONTINUITY if the entered waypoint was not in original flight plan.

EXEC key .... Push

Observe MOD RTE LEGS page changes to ACT.

LNAV may disengage after execution of an intercept leg to a waypoint. If LNAV disengages, turn to a heading to satisfy LNAV capture criteria, as described in Chapter 11, and then engage LNAV.

Route Modification

RTE LEGS or RTE page .... Select

Line select existing waypoints in the desired sequence.

Key–in any new waypoints in the scratch pad and line select into the flight plan. Correct any ROUTE DISCONTINUITY.

EXEC key .... Push

Observe MOD RTE or MOD RTE LEGS page changes to ACT.

Active Route Modification

ACT RTE x LEGS or ACT RTE x page.. Select

Line select existing waypoints in the desired sequence.

Key–in any new waypoints in the scratch pad and line select into the flight plan. Correct any ROUTE DISCONTINUITY.

EXEC key .... Push

Observe MOD RTE x LEGS or MOD RTE x page changes to ACT.

Inactive Route Modification

RTE x LEGS or RTE x page .... Select

Line select existing waypoints in the desired sequence.

Key–in any new waypoints in the scratch pad and line select into the flight plan. Correct any ROUTE DISCONTINUITY.

Note: The flight number should not be changed in the inactive route as it will change the flight number in the active route.

Route Copy

ACT RTE x LEGS or ACT RTE x page .... Select

RTE COPY line select key .... Push

Inactive Route Activation

RTE x LEGS or RTE x page .... Select

ACTIVATE line select key .... Push

Correct any ROUTE DISCONTINUITY.

EXEC key .... Push

Route Removal

RTE page .... Select

ORIGIN .... Enter

If EXEC key illuminates

EXEC key .... Push

Linking a Route Discontinuity

Correct the ROUTE DISCONTINUITY by entering or deleting waypoints in a sequence that provides a continuous flight–plan path.

EXEC key .... Push

Observe MOD RTE or MOD RTE LEGS page changes to ACT.

Determining ETA and Distance to Cross Radial (Bearing) or Distance from a Fix

FIX INFO page .... Select

Enter the identifier of the reference waypoint (normally an off–route waypoint) onto the FIX line. Enter the desired radial or distance from the FIX on a RAD/DIS line, or line select the ABM prompt if the desired radial from the FIX is perpendicular to the present route/course.

Time and distance to go .... Check

Check ETA and DTG, as desired.

Note: If ETA and DTG are not displayed, the fix radial and/or distance do not intersect the route.

Changing Destination

RTE page .... Select

Enter the new destination over the original DEST. Enter desired routing to the new destination using the RTE, RTE LEGS, and ARRIVALS pages, as appropriate. Correct any ROUTE DISCONTINUITY.

EXEC key .... Push

Observe the MOD RTE or MOD RTE LEGS page changes to ACT.

Note: If destination is changed during climb, performance predictions may be blanked if the new flight plan is incompatible with the entered cruise altitude. Correct by entering a lower CRZ ALT on the CLB page.

Entering Holding Fix Into Route

HOLD key .... Push

(If RTE HOLD page is displayed, observe NEXT HOLD prompt. Line select 6L until (RTE LEGS) HOLD AT page is displayed.)

Observe HOLD AT box prompts and PPOS prompt (if in flight) are displayed. Enter the holding fix in line 6L, or line select PPOS.

If the holding fix is a waypoint in the active route, or PPOS was selected, observe MOD RTE HOLD page displayed. If the holding fix is a waypoint not in the active route, observe message HOLD AT XXXXX displayed in the scratch pad. Enter the holding fix into the route by line selecting in the desired waypoint sequence. Observe the MOD RTE HOLD page displayed. If displayed holding details are incorrect or inadequate, enter correct information on appropriate line(s).

EXEC key .... Push

Observe MOD RTE HOLD page changes to RTE HOLD (ACT RTE HOLD if holding at PPOS).

Exiting Holding Pattern

HOLD key .... Push

Observe EXIT HOLD prompt displayed.

EXIT HOLD line select key .... Push

Observe EXIT HOLD prompt changes to EXIT ARMED.

EXEC key .... Push

Observe EXIT ARMED is highlighted in reverse video and LNAV flight returns to the holding fix and resumes the active route.

Note: The holding pattern may be exited by performing a DIRECT TO modification if desired. In this case, the flight path may not return to the holding fix before proceeding to the selected waypoint.

Note: A late sequencing of the hold exit waypoint may occur if multiple route modifications are performed just prior to exiting the hold. LNAV guidance may be temporarily interrupted while sequencing the hold exit waypoint.

Along Track Displacement

RTE LEGS page .... Select

Line select the reference waypoint to the scratch pad. Add a "/" and the + or – distance desired. (EX: SEA/15 for a point 15 miles downtrack from SEA)

Line select the reference waypoint. (The FMC will automatically position the created waypoint to appropriate position.)

EXEC key .... Push

Observe the MOD RTE LEGS page change to ACT.

Entering Created Waypoints on the Route or Route Legs Pages

Note: Created waypoints are stored in the temporary navigation data base for one flight only.

RTE or RTE LEGS page .... Select

Using any of the following methods, key into the scratch pad the parameters which define the new created waypoint (place identifiers must already be stored in one of the FMC data bases):

- Place bearing/distance (for example, SEA250/40);
- Place bearing/place bearing (for example, SEA180/ELN270);
- Along–track displacement (for example, SEA/-10);
- Latitude and longitude (for example, N4731.8W12218.3).

Enter into the route by line selecting to the appropriate waypoint sequence.

Repeat the above steps to define additional created waypoints as desired. Correct any ROUTE DISCONTINUITY.

EXEC key .... Push

Observe the MOD RTE or MOD RTE LEGS page changes to ACT (for an inactive route, activate and execute on the RTE or RTE LEGS page).

Entering Created Waypoints on the Nav Data Pages

Note: Created waypoints entered on the SUPP NAV DATA pages (permitted on the ground only) are stored in the supplemental navigation data base for an indefinite time period; those entered on REF NAV DATA pages are stored in the temporary navigation data base for one flight only.

INIT/REF key .... Push

Observe INDEX prompt displayed.

INIT/REF INDEX page .... Select

Observe the NAV DATA prompt displayed. To access the SUPP NAV DATA page, enter SUPP into the scratch pad.

NAV DATA page .... Select

(If the SUPP NAV DATA page is selected, observe the EFF FRM date line displayed. If an effective date had not been previously entered, box prompts are displayed. The effective date must be entered before proceeding. If required, enter the current or appropriate date on EFF FRM line and execute.)

Data ....Enter

Enter a crew-assigned identifier on either the WPT IDENT, NAVAID IDENT, or AIRPORT IDENT line, as appropriate. Use the navaid category only for stations with DME.

For a WPT IDENT entry, define the waypoint with entries for either latitude and longitude, or with entries for REF IDENT and RADIAL/DIST (REF IDENT identifier must already be stored in one of the FMC data bases).

For a NAVAID IDENT or AIRPORT IDENT entry, enter appropriate data.

EXEC key illuminates when data has been entered into all box prompts.

EXEC key .... Push

Repeat above steps to define additional created waypoints as desired. To enter a new identifier in the same category, simply overwrite the previous identifier.

Note: To enter a created waypoint into the flight plan, key the identifier into the scratch pad and follow the route modification procedure.

Deleting Created Waypoints on the Nav Data Pages

INIT/REF key .... Push

Observe the INDEX prompt displayed.

INIT/REF INDEX page .... Select

Observe the NAV DATA prompt displayed. To access the SUPP NAV DATA page, key SUPP into the scratch pad.

NAV DATA page .... Select

Enter the identifier on either the WPT IDENT, NAVAID IDENT, or AIRPORT IDENT line, as appropriate.

Data .... Delete

Push the DEL key and then line select the identifier. Observe the EXEC key illuminates.

EXEC key .... Push

Data previously entered is deleted. Observe NAV DATA page displayed with prompts.

Entering a Crossing Radial (Bearing) or Distance from a Fix as a Route Waypoint

FIX INFO page .... Select

Enter identifier of the reference waypoint (normally an off–route waypoint) onto the FIX line. Enter the desired radial or distance from the FIX on a RAD/DIS line, or line select the ABM prompt if the desired radial or distance from the FIX is perpendicular to the present route/course.

Line select the desired intersection (lines 2L–5L) into the scratch pad and observe the new created waypoint displayed as FIX/Radial/Distance.

RTE LEGS page .... Select

Line select the new created waypoint, displayed in the scratch pad, to the desired waypoint sequence.

Repeat the above steps to define additional created waypoints as desired. Correct any ROUTE DISCONTINUITY.

EXEC key .... Push

Observe the MOD RTE LEGS page changes to ACT.

Note: These created waypoints are stored in the temporary navigation data base for one flight only.

Entering a Lateral Offset

RTE page .... Select

Observe the OFFSET prompt displayed.

LATERAL OFFSET page .... Select

Observe dash prompts for OFFSET DIST.

OFFSET DIST..Enter

Enter desired offset distance using format Lxx or Rxx for left or right offset up to 99 nm. Observe dash prompts for START WAYPOINT and END WAYPOINT.

START/END WAYPOINT ....Enter

If no start/end waypoint is entered, offset will begin/end at first/last valid offset leg.

Change SID or Runway

This entire procedure must be accomplished when a SID is used and the runway or SID is changed. This will prevent the possibility of incorrect routing or inadequate obstacle clearance.

DEPARTURES page .... Select

RUNWAY..Reselect

SID ....Reselect

TRANSITION (if required) .... Reselect

RTE LEGS page .... Select

WAYPOINT SEQUENCE and ALTITUDES .... Check

Modify as necessary to agree with clearance.

EXEC key .... Push

Change STAR, PROF DES, or APP

The associated airport must be entered as route origin or destination.

ARRIVAL page .... Select

STAR or PROFILE DESCENT (if required) .... Select

TRANSITION (if required) .... Select

APPROACH .... Select

APPROACH TRANSITION (if required) .... Select

RTE LEGS page .... Select

WAYPOINT SEQUENCE .... CHECK

Modify as necessary to agree with clearance.

EXEC key .... Push

Delete Procedure Turn

DEP/ARR page .... Select

Approach .... Select

Reselecting same approach or selecting a new approach will remove procedure turn and select a straight in approach on the LEGS page.

EXEC key .... Push

or

RTE LEGS page .... Select

Select last waypoint of procedure turn to scratchpad and overwrite PROC TURN line. Check waypoint sequencing to comply with clearance.

EXEC key .... Push

Other Operations

FMC Navigation Check

Do the following as needed to ensure navigation accuracy if any alerting message listed below is shown in the scratch pad or course deviation is suspected:

- GPS-L INVALID and GPS-R INVALID (both)
- IRS-L DRIFT
- IRS-R DRIFT
- UNABLE REQD NAV PERF - RNP
- VERIFY POS: FMC-FMC
- VERIFY POS: FMC-GPS
- VERIFY POS: FMC-RADIO
- VERIFY POS: IRS-FMC
- VERIFY POS: IRS-IRS
- VERIFY POS: IRS-RADIO

Actual position .... Determine and compare with FMC position

Determine actual airplane position using raw data from VHF navigation or ADF radios.

If radio navaids are unavailable:

FMC position .... Compare with the IRS position

Use the POS SHIFT page of the FMC CDU. If the two IRS positions are in agreement and the FMC position is significantly different, the FMC position is probably unreliable. The POS SHIFT page may be used to shift FMC position to one of the IRS positions. This is accomplished by line selecting the IRS or radio position and then pressing the EXEC Key.

Actual position .... Confirm with ATC radar or visual reference points.

Navigate using most accurate information available (continue to monitor FMC position using VOR/ADF raw data displays on non–flying pilot's navigation display).

CAUTION: Navigating in LNAV mode with an unreliable FMC position may result in significant navigation errors.

Navigate by conventional VOR/ADF procedures, radar vectors from ATC, dead reckoning from last known position, and/or use of visual references.

Inhibiting VOR/DME Use for Position Updating

Note: This procedure inhibits the use of VOR/DME information for FMC position updating. Use DEL key to remove a VOR/DME from inhibit status.

PROG page .... Select

Observe NAV STATUS prompt displayed.

NAV STATUS page .... Select

NAV OPTIONS page .... Select (NEXT/PREV page)

Observe dash prompts for VOR/DME INHIBIT. Enter desired VOR/DME identifier (a previous entry may be overwritten but will no longer be inhibited).

Inhibiting GPS Updating

Note: Inhibit GPS updates for approach operations that are not based on WGS-84, unless other appropriate procedures are used.

PROG page .... Select

Observe NAV STATUS prompt displayed.

NAV STATUS page .... Select

NAV OPTIONS page .... Select (NEXT/PREV page)

GPS UPDATE .... OFF

Vertical Navigation (VNAV)

Temporary Level Off during Climb or Descent (Not at FMC Cruise Altitude)

MCP altitude selector .... Set desired altitude

Verify VNAV ALT or ALT HOLD is annunciated on the flight mode annunciator when leveling at the selected MCP altitude.

MCP N1 light extinguishes if leveling from a climb.

N1 limit changes to CRZ if leveling from a climb.

To continue climb or descent:

MCP altitude selector .... Set desired altitude

ALT INTV switch (as installed)..Push

Climb or descent is initiated. Mode annunciations appear as initial climb or descent.

VNAV switch ....Push

Climb or descent is initiated. Mode annunciations appear as initial climb or descent.

Intervention of FMC Altitude Constraints during VNAV Climb

MCP altitude selector .... Set new altitude

New altitude must be higher than the FMC altitude constraint(s) to be deleted.

ALT INTV switch .... Push

Each push of the ALT INTV switch will delete an FMC altitude constraint.

Intervention of FMC Cruise Altitude during VNAV Cruise

MCP altitude selector ....Set

ALT INTV switch .... Push

If a higher altitude is selected, a CRZ climb will be started.

If the airplane is more than 50 nm from T/D, if a lower altitude is selected, a CRZ descent will be started if the selected altitude is at or above any FMC altitude constraint.

If the airplane is more than 50 nm from T/D, if a lower altitude is selected, an early descent will be started if the selected altitude is below any FMC altitude constraint.

If the airplane is 50 nm or less from T/D, if a lower altitude is selected, an early descent will be started.

Intervention of FMC Altitude Constraints during VNAV Descent

MCP altitude selector .... Set new altitude

New altitude must be lower than the FMC altitude constant (s) to be deleted.

ALT INTV switch .... Push

Each push of the ALT INTV switch will delete an FMC altitude constraint.

If all FMC altitude constraints are deleted, the descent mode will revert to a VNAV speed descent.

Intervention of FMC Airspeed Constraints during VNAV

SPD INTV switch .... Push

MCP IAS/MACH display shows current FMC target speed.

MCP speed selector .... Set desired speed

VNAV remains engaged.

To resume former FMC speed:

SPD INTV switch .... Push

MCP IAS/MACH display blanks and FMC commanded VNAV speed is active.

Entering Waypoint Speed and Altitude Restriction (On Climb or Descent Legs Only)

RTE LEGS page .... Select

Key–in desired speed and altitude, or speed only (followed by /), or altitude only, into scratch pad.

An altitude followed by A or B signifies a requirement to be “at or above” or “at or below” that altitude at the waypoint (for example, key–in 220A or 240B).

Line select to desired waypoint line.

EXEC key .... Push

Observe MOD RTE LEGS page changes to ACT.

Note: This changes any prior speed and altitude restriction at this waypoint.

Deleting Waypoint Speed and Altitude Restriction

RTE LEGS page .... Select

Push DEL key to enter DELETE in scratch pad. Line select to appropriate waypoint line.

EXEC key .... Push

Observe MOD RTE LEGS page changes to ACT and restriction is deleted and replaced with an FMC predicted value (small size characters).

Changing Speed and/or Altitude Restriction during Climb or Descent

CLB/DES page .... Select

Push DEL key to enter DELETE in the scratch pad, or key–in the desired speed and altitude in the scratch pad. Line select to the SPD REST line.

EXEC key .... Push

Observe the MOD CLB or the MOD DES page changes to ACT and the restriction is changed or deleted.

Changing Climb/Cruise/Descent Speed Schedule

CLB/CRZ/DES page .... Select

Select the prompt for the desired climb/cruise/descent schedule, or key–in the desired speed in the scratch pad and line select to the TGT SPD line.

EXEC key .... Push

Observe the MOD CLB, MOD CRZ, or MOD DES page changes to ACT and new speed schedule is specified.

Early Descent

MCP altitude selector .... Set

Set next level–off altitude.

DES page .... Select

Line select DES NOW prompt.

EXEC key .... Push

Observe MOD DES page changes to ACT. Observe descent is initiated (if VNAV engaged).

Note: For a PATH DES, this will result in a 1000 FPM rate of descent until the planned path is intercepted. For a SPD DES, this will result in an idle thrust normal rate of descent.

Step Climb or Descent from Cruise

MCP altitude selector .... Set

Set new level–off altitude.

FLT ALT indicator .... Set

Set new level–off altitude.

CRZ page .... Select

Enter new altitude on the CRZ ALT line. The display changes to MOD CRZ CLB or MOD CRZ DES.

If the desired climb/descent speed is different from the displayed cruise speed, manually enter the desired TGT SPD, or use access prompts to select desired CLB/DES page.

EXEC key .... Push

Observe the MOD CRZ CLB/MOD CRZ DES page (or other selected MOD CLB/MOD DES page) changes to ACT. Observe climb/descent is initiated at the TGT SPD (if VNAV engaged).

Performance and Progress Functions

Determining ETA and Fuel Remaining for New Destination

RTE page .... Select

Enter the new destination over the original DEST. Enter correct routing to the new destination using RTE, RTE LEGS, and ARRIVALS pages, as appropriate. Correct any ROUTE DISCONTINUITY.

PROGRESS page .... Select

Observe new destination with a MOD title. Check ETA and FUEL remaining.

RTE page .... Select

EXEC or ERASE the new destination/routing, as desired. Observe MOD RTE page changes to ACT.

Estimated Wind Entries for Cruise Waypoints

RTE LEGS page .... Select

Observe the DATA prompt displayed.

RTE DATA page .... Select

Enter the estimated true wind direction/speed on the appropriate line(s).

Step Climb Evaluation

CRZ page .... Select

Enter the desired step climb altitude on the STEP line. If known, enter the estimated average true wind direction/speed for the desired step climb altitude on the ACTUAL WIND line.

Step climb savings .... Determine

Observe the fuel SAVINGS/PENALTY and FUEL AT ______ (destination) lines to determine if a higher cruise altitude is advantageous.

If step climb fuel savings are significant, use the appropriate climb procedure to initiate climb to the higher altitude when NOW is displayed on STEP POINT line.

Note: Step climb evaluations do not consider buffet margin limits. If the altitude entered for the step climb evaluation is higher than the maximum altitude for flight with an adequate buffet margin, the message “MAX ALT FLXXX” will be displayed in the scratch pad. Ensure the new cruise altitude entered for the climb is at or below the MAX ALT displayed in the message in order to maintain a safe buffet margin.

Entering Descent Forecasts

DES page.. Select

Observe FORECAST prompt displayed.

DES FORECASTS page .... Select

Verify the TRANS LVL and revise if required. Enter average ISA DEV forecast for descent and destination QNH. Enter forecast descent WINDs (for up to three different altitudes).

EXEC key .... Push

Observe MOD DES FORECASTS page changes to ACT.

Engine Out

Engine out climb and cruise pages provide advisory information for engine out operation. Refer to section 11.41 and 11.42 for a complete description of ENG OUT CLB and ENG OUT CRZ pages.

Required Time of Arrival (RTA)

Note: An active FMC flight plan complete with all performance data must exist before the required time of arrival (RTA) mode can be used.

Entering an RTA Waypoint and Time

RTA PROGRESS page .... Select

On PROGRESS page 2, line 1L, enter the flight plan waypoint where required time of arrival is applicable. Observe the MOD RTA PROGRESS page displayed with the computed ETA, for the entered waypoint, displayed in line 1R.

RTA .... Enter

Enter required time of arrival into line 1R. Time should be entered in hours, minutes, and seconds (Examples: 174530, 1745, 1745.5). Observe MOD RTA PROGRESS page displayed with pertinent data for complying with entered RTA. Observe EXEC key illuminated.

EXEC key .... Push

Observe ACT RTA PROGRESS page displayed.

Entering Speed Restrictions for RTA Navigation

PERF LIMITS page .... Select

Enter minimum or maximum speed restriction for RTA navigation in lines 2, 3, or 4 depending on phase of flight. Observe RTA parameters change to reflect new limits (RTA PROGRESS page) and EXEC key illuminated.

EXEC key .... Push

Observe MOD PERF LIMITS page change to ACT PERF LIMITS page.

Note: Entered restrictions on line 2, 3, and 4 also restrict other navigation modes such as ECON.

Entering New Time Error Tolerances for RTA Navigation

PERF LIMITS page .... Select

Enter desired time error tolerance (5 to 30 seconds) for the RTA waypoint on line 1L (Example: 25). Observe MOD PERF LIMITS page displayed and EXEC key illuminated.

EXEC key .... Push

Observe ACT PERF LIMITS page displayed.

Additional CDU Functions

Navigation Display Plan Mode (Center Step Operation)

EFIS Control Panel Mode Selector ....PLAN

RTE LEGS page .... Select

EFIS Control Panel Range Selector .... As required

MAP CTR STEP key .... Push

Each push moves the CTR label to the next geographically fixed waypoint in the route. Selecting PREV PAGE or NEXT PAGE moves the CTR label to the first geographically fixed waypoint on the new page.

EFIS Control Panel Mode Selector .... As required

Enter Position Shift on Runway

TAKEOFF REF page .... Select

TO SHIFT distance (as intalled) ....Enter

Enter distance desired from runway threshold. When TO/GA is pushed, FMC will update position to runway threshold plus entered distance.

RWY REMAIN distance (as installed) ....Enter

Enter runway remaining distance. When TO/GA is pushed, FMC will update to the runway remaining distance.

If position shift must be removed

RTE page... Select

RWY ....Enter

Reenter runway on RTE page. Check and reenter other performance data as required.

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Spar Fuel Shutoff Valve Operational Check

Note: Regulatory approval for use of the following flight crew procedure(s) is required.

Note: The check is considered failed for any of the following procedures if the SPAR VALVE CLOSED light (located on the fuel control panel) fails to illuminate bright during the check.

Unless accomplished by maintenance personnel, do **one** of the 3 following spar fuel shutoff valve checks once per flight day:

1. Spar Fuel Shutoff Valve Operational Check with Engine(s) Shutdown

With AC power established on the airplane:

Verify that the engine No. 1 and engine No. 2 fire switches are in.

ENGINE START switches .... OFF

Engine start lever (first engine) .... IDLE

Note: During this check it is normal for the ENG VALVE CLOSED light to transition from dim to bright, and remain bright.

Wait for approximately 10 seconds

Engine start lever (first engine) .... CUTOFF

Verify SPAR VALVE CLOSED light transitions from extinguished, to bright and then dim.

Engine start lever (second engine) .... IDLE

Note: During this check it is normal for the ENG VALVE CLOSED light to transition from dim to bright, and remain bright.

Wait for approximately 10 seconds

Engine start lever (second engine) .... CUTOFF

Verify SPAR VALVE CLOSED light transitions from extinguished, to bright and then dim.

2. Spar Fuel Shutoff Valve Operational Check During Engine Start

Engine start lever (first engine) .... IDLE

Verify SPAR VALVE CLOSED light transitions from dim, to bright and then extinguishes.

Engine start lever (second engine) .... IDLE

Verify SPAR VALVE CLOSED light transitions from dim, to bright and then extinguishes.

3. Spar Fuel Shutoff Valve Operational Check During Engine Shutdown

Engine start lever (first engine) .... CUTOFF

Verify SPAR VALVE CLOSED light transitions from extinguished, to bright and then dim.

Engine start lever (second engine) .... CUTOFF

Verify SPAR VALVE CLOSED light transitions from extinguished, to bright and then dim.

Fuel Balancing

If an engine fuel leak is suspected:

Accomplish the Fuel Leak Engine checklist.

If the fuel IMBAL alert shows:

Accomplish the IMBAL checklist.

Maintain main tank No. 1 and No. 2 fuel balance within limitations.

Note: Fuel pump pressure should be supplied to the engines at all times. At high altitude, without fuel pump pressure, thrust deterioration or engine flameout may occur.

If the center tank contains fuel:

Center tank fuel pump switches .... OFF

[Fuel CONFIG indication may be displayed with fuel in the center tank.]

Crossfeed selector .... Open

Fuel pump switches (low tank) .... OFF

When quantities are balanced:

Fuel pump switches (main tank) .... ON

Center tank fuel pump switches .... ON

Crossfeed selector .... Close

If the center tank contains no fuel:

Crossfeed selector .... Open

Fuel pump switches (low tank) .... OFF

When quantities are balanced:

Fuel pump switches .... ON

Crossfeed selector .... Close

Refueling

Fuel Load Distribution

Main tanks No. 1 and No. 2 should normally be serviced equally until full. Additional fuel is loaded into the center tank until the desired fuel load is reached.

Note: Main tanks No. 1 and No. 2 must be scheduled to be full if the center tank contains more than 453 kgs of fuel. With less than 453 kgs of center tank fuel, partial main tank fuel may be loaded provided the effects of balance have been considered.

Fuel Pressure

Apply from a truck or fuel pit. A nozzle pressure of 50 psi provides approximately 1136 liters per minute.

Normal Refueling

When a full fuel load is required, the fuel shutoff system closes the fueling valves automatically when the tanks are full. When a partial fuel load is required, the fuel quantity indicators are monitored and the fueling valves are closed by manually positioning the fueling valve switches to CLOSED when the desired fuel quantity is aboard the airplane.

Refueling with Battery Only

When the APU is inoperative and external power is not available, refueling can be accomplished as follows:

Battery switch .... ON

Note: The refueling system will operate normally. Operation is limited only by battery life.

Refueling with No AC or DC Power Source Available

When it becomes necessary to refuel with the APU inoperative, the aircraft battery depleted, and no external power source available, refueling can still be accomplished:

Fueling hose nozzle ....Attached to the refueling receptacle

Fueling valves .... Open for the tanks to be refueled

Note: Main tanks No. 1 and No. 2, and the center tank refueling valves each have a red override button that must be pressed and held while fuel is being pumped into the tank. Releasing the override button allows the spring in the valve to close the valve.

Caution must be observed not to overfill a tank, since there is no automatic fuel shutoff during manual operation. When the desired amount of fuel has been pumped into the tanks, the refueling valves for the respective tanks can be released.

Ground Transfer of Fuel

Fuel can be transferred from one tank to another tank using the fuel pumps, fueling valve, defueling valve, and crossfeed valve. AC power must be available.

Note: Before transferring fuel, ensure that the associated FUEL PUMP LOW PRESSURE lights are operating.

CAUTION: Transferring fuel with passengers onboard is prohibited, unless the fuel quantity in the tank from which fuel is being taken is maintained at or above 2000 pounds/900 kilograms.

To transfer fuel from the main tanks to the center tank:

Main tank fuel pump switches ....ON

Crossfeed selector ....Open

Manual defueling valve ....Open

Center tank fueling valve switch ....OPEN

Fuel transfer.. Monitor

The center tank fuel quantity indicator shows an increase in fuel. The main tank indicators show a decrease in fuel.

When a FUEL PUMP LOW PRESSURE light illuminates, turn OFF the associated fuel pump.

When the required amount of fuel has been transferred:

Center tank fueling valve switch ....CLOSED

Manual defueling valve ....Close

Crossfeed selector .... Close

Main tank fuel pump switches .... OFF

Main Tanks .... Refill

Refueling panel and defuel panel access doors .... Close

Fuel Crossfeed Valve Check

Crossfeed selector .... Open

Verify crossfeed VALVE OPEN light illuminates bright and then dim.

Crossfeed selector .... Close

Verify crossfeed VALVE OPEN light illuminates bright and then extinguishes.

Ground Proximity Warning System (GPWS) Test

Verify IRS alignment is complete.

Verify that the guards are closed for all GROUND PROXIMITY INHIBIT switches.

Ground proximity SYS TEST switch .... Push momentarily

Verify the following:

- BELOW G/S and GPWS INOP lights illuminate
- TERR FAIL and TERR TEST annunciations show on navigation displays
- PULL UP and WINDSHEAR alerts illuminate
- "GLIDESLOPE", "PULL UP" and “WINDSHEAR" aurals sound
- "TERRAIN TERRAIN PULLUP" aural sounds
- terrain display test pattern shows on navigation displays
- TERRAIN caution message shows on navigation displays.
- "OBSTACLE OBSTACLE PULLUP" aural sounds
- "AIRSPEED LOW" aural sounds

Note: If the test switch is held until the aurals begin, additional GPWS aural warnings are tested.

Ground Proximity Warning System (GPWS), Overrun Warning (ORW) System, and Runway Awareness and Advisory System (RAAS) Test

Verify IRS alignment is complete.

Verify that the guards are closed for all GROUND PROXIMITY INHIBIT switches.

Ground proximity SYS TEST switch .... Push momentarily

Verify the following:

- BELOW G/S and GPWS INOP lights illuminate
- TERR FAIL and TERR TEST annunciations show on navigation displays
- PULL UP and WINDSHEAR alerts illuminate
- “GLIDESLOPE”, “PULL UP” and “WINDSHEAR" aurals sound.

- “TERRAIN TERRAIN PULLUP" aural sounds
- terrain display test pattern shows on navigation displays
- TERRAIN caution message shows on navigation displays.
- "OBSTACLE OBSTACLE PULLUP" aural sounds
- RAAS database version (RCD xxxxx) shows on navigation displays.

During the test the RUNWAY INOP light illuminates and one of the following aurals will announce the status of the ORW and RAAS system:

- RUNWAY AWARENESS OK - FEET/METERS (As installed)
- RUNWAY AWARENESS NOT AVAILABLE
- RUNWAY AWARENESS INOP
- "AIRSPEED LOW" aural sounds

Note: If the test switch is held until the aurals begin, additional GPWS aural warnings are tested.

Overrun Warning (ORW) System and Runway Awareness and Advisory System (RAAS) Inhibit Operation

Before departure if one or more of the following exist:

- The airport or runway is not in the GPWS database
- A NOTAM applies to the intended runway
- Airline policy prohibits the use of RAAS for an airport or runway.

RUNWAY INHIBIT switch .... INHIBIT

Note: If the RUNWAY INHIBIT switch is in the INHIBIT position, and the airspeed is 250 knots or greater for 60 seconds or more, the RUNWAY INOP light illuminates. The RUNWAY INOP light extinguishes when airspeed is below 250 knots.

After takeoff:

RUNWAY INHIBIT switch .... NORM

Before approach if one or more of the following exist or are planned:

- The airport is not in the GPWS database
- A NOTAM applies to the intended runway
- Airline policy prohibits the use of ORW for an airport or runway.
- Conducting Land and Hold Short Operations (LAHSO).
- Conducting Touch and Go landings
- Landing altitude is above 10,000 feet pressure altitude

- Landing OAT on the ground is below -40°C or greater than +50°C
- Gross weight is greater than maximum landing weight.

RUNWAY INHIBIT switch ....INHIBIT

Note: If the RUNWAY INHIBIT switch is in the INHIBIT position, and the airspeed is 250 knots or greater for 60 seconds or more, the RUNWAY INOP light illuminates. The RUNWAY INOP light extinguishes when airspeed is below 250 knots.

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Introduction

Airplane operation in adverse weather conditions may require additional considerations due to the effects of extreme temperatures, precipitation, turbulence and windshear. Procedures in this section supplement normal procedures and should be observed when applicable.

Takeoff - Wet or Contaminated Runway Conditions

The following information applies to takeoffs on wet or contaminated runways:

- For wet runways, reduced thrust (fixed derate, assumed temperature method, or both) is allowed provided suitable takeoff performance accountability is made for the increased stopping distance on a wet surface
- For runways contaminated by slush, snow, standing water, or ice, reduced thrust (fixed derate) is allowed provided takeoff performance accounts for the runway surface condition. Reduced thrust using assumed temperature method, whether alone or in combination with a fixed derate, is not allowed
- V1 may be reduced to minimum V1 to provide increased stopping margin provided the field length required for a continued takeoff from the minimum V1 and obstacle clearance meet the regulatory requirements. The determination of such minimum V1 may require a real-time performance calculation tool or other performance information supplied by dispatch
- Takeoffs are not recommended when slush, wet snow, or standing water depth is more than 1/2 inch (13 mm) or dry snow depth is more than 4 inches (102 mm).

Cold Weather Operations

Considerations associated with cold weather operation are primarily concerned with low temperatures and with ice, snow, slush and standing water on the airplane, ramps, taxiways, and runways.

Icing conditions exist when OAT (on the ground) or TAT (in flight) is 10°C or below and any of the following exist:

- visible moisture (clouds, fog with visibility of one statute mile (1600m) or less, rain, snow, sleet, ice crystals, and so on) is present, or
- ice, snow, slush or standing water is present on the ramps, taxiways, or runways.

CAUTION: Do not use engine or wing anti–ice when OAT (on the ground) or TAT (in flight) is above 10°C.

Exterior Inspection

Although removal of surface snow, ice and frost is normally a maintenance function, during preflight procedures, the captain or first officer should carefully inspect areas where surface snow, ice or frost could change or affect normal system operations.

Do the normal Exterior Inspection with the following additional steps:

Surfaces .... Check

Takeoff with light coatings of frost, up to 1/8 inch (3 mm) in thickness, on lower wing surfaces due to cold fuel is allowable; however, all leading edge devices, all control surfaces, tab surfaces, upper wing surfaces, winglet surfaces and control surface balance panel cavities must be free of snow, ice and frost.

Thin hoarfrost is acceptable on the upper surface of the fuselage provided all vents and ports are clear. Thin hoarfrost is a uniform white deposit of fine crystalline texture, which usually occurs on exposed surfaces on a cold and cloudless night, and which is thin enough to distinguish surface features underneath, such as paint lines, markings or lettering.

Control surface balance panel cavities .... Check

Check drainage after snow removal. Puddled water may freeze in flight.

Pitot probes and static ports .... Check

Verify that all pitot probes and static ports free of snow and ice. Water rundown after snow removal may freeze immediately forward of static ports and cause an ice buildup which disturbs airflow over the static ports resulting in erroneous static readings even when static ports are clear.

Air conditioning inlets and exits .... Check

Verify that the air inlets and exits, including the outflow valve, are free of snow and ice.

If the APU is operating, verify that the outflow valve is fully open.

Engine inlets .... Check

Verify that the inlet cowling is free of snow and ice.

Verify that the fan is free to rotate.

Snow or ice that accumulates on the fan spinner or fan blades during extended shutdown periods must be removed by maintenance or other means before engine start.

Snow or ice that accumulates on the fan spinner or fan blades as a result of operation in icing conditions, such as during approach or taxi in, is allowed if the fan is free to rotate and the snow or ice is removed using the ice shedding procedure during taxi out and before setting takeoff thrust.

Fuel tank vents .... Check

Verify all traces of ice and frost are removed.

Landing gear doors .... Check

Landing gear doors should be free of snow and ice.

APU air inlets .... Check

The APU inlet door and cooling air inlet must be free of snow and ice before APU start.

Preflight Procedure - First Officer

Do the following step after completing the normal Preflight Procedure - First Officer:

PROBE HEAT switches ....ON

Verify that all probe heat lights are extinguished.

Engine Start Procedure

Do the normal Engine Start Procedure with the following modifications:

- If the engine has been cold soaked for one or more hours at ambient temperatures below -40°C, do not start or motor the engine. Maintenance personnel should do appropriate procedures for adverse weather heating of the Hydro-Mechanical Unit.
- If the engine has been cold soaked for three or more hours at ambient temperatures below -40°C, do not start or motor the engine. Maintenance personnel should do appropriate procedures for adverse weather starter servicing.
- If ambient temperature is below -35°C, idle the engine for two minutes before changing thrust lever position.
- Several minutes may be needed for oil pressure to reach the normal operating pressure. During this period, oil pressure may go above the normal range and the OIL FILTER BYPASS light may illuminate. Operate the engine at idle thrust until oil pressure returns to the normal range.
- If the oil pressure remains above the normal range after the oil temperature has stabilized within limits, shut down the engine.
- Display units may require additional warm-up time before displayed engine indications accurately show changing values. Display units may appear less bright than normal.

Engine Anti-ice Operation - On the Ground

Engine anti-ice must be selected ON immediately after both engines are started and remain on during all ground operations when icing conditions exist or are anticipated.

WARNING: Do not rely on airframe visual icing cues before activating engine anti-ice. Use the temperature and visible moisture criteria because late activation of engine anti-ice may allow excessive ingestion of ice and result in engine damage or failure.

CAUTION: Do not use engine anti-ice when OAT is above 10°C.

When engine anti-ice is needed:

ENGINE START switches .... CONT F/O

ENGINE ANTI-ICE switches .... ON F/O

Verify that the COWL VALVE OPEN lights illuminate bright, then dim.

Verify that the COWL ANTI-ICE lights are extinguished.

Note: If the COWL VALVE OPEN lights remain illuminated bright with engines at IDLE, do the following:

- verify APU BLEED air switch is in the OFF posiiton,
- verify ISOLATION VALVE switch is in the AUTO position,
- check that the area around the airplane is clear, and
- increase thrust slightly (up to a maximum of 30% N1).

When engine anti-ice is no longer needed:

ENGINE ANTI-ICE switches .... OFF F/O

Verify that the COWL VALVE OPEN lights illuminate bright, then extinguish.

Wing Anti-ice Operation - On the Ground

Use wing anti-ice during all ground operations between engine start and takeoff when icing conditions exist or are anticipated, unless the airplane is, or will be protected by the application of Type II or Type IV fluid in compliance with an approved ground de-icing program.

WARNING: Do not use wing anti-ice as an alternative for ground de-icing/anti-icing. Close inspection is still needed to ensure that no frost, snow or ice is adhering to the wing, leading edge devices, stabilizer, control surfaces or other critical airplane components at takeoff.

CAUTION: Do not use wing anti-ice when OAT is above 10°C.

When wing anti-ice is needed:

WING ANTI-ICE switch .... ON F/O

Verify that the L and R VALVE OPEN lights illuminate bright, then dim.

Note: The wing anti-ice VALVE OPEN lights may cycle bright/dim due to the control valves cycling closed/open in response to thrust setting and duct temperature logic.

When wing anti-ice is no longer needed:

WING ANTI-ICE switch .... OFF F/O

Verify that the L and R VALVE OPEN lights illuminate bright, then extinguish.

Before Taxi Procedure

Do the normal Before Taxi Procedure with the following modifications:

GENERATOR 1 and 2 switches ....ON F/O

Normally the IDG's stabilize within one minute, although due to cold oil, up to five minutes can be needed to produce steady power.

If there is snow or ice accumulation on the wing, consider delaying the flight control check until after de-icing/anti-icing is accomplished.

Flight controls .... Check C

An increase in control forces can be expected at low temperatures.

CAUTION: The flap position indicator and the leading edge devices annunciator panel should be closely observed for positive movement. If the flaps should stop, the flap lever should be placed immediately in the same position as indicated.

Flaps .... Check F/O

Move the flaps from Flaps up to Flaps 40 back to Flaps up (i.e., full travel) to ensure freedom of movement.

If taxi route is through ice, snow, slush or standing water in low temperatures or if precipitation is falling with temperatures below freezing, taxi out with the flaps up. Taxiing with the flaps extended subjects the flaps and flap drives to contamination. Leading edge devices are also susceptible to slush accumulations.

Call "FLAPS ___" as needed. C

Flap lever...Set flaps, as needed F/O

Taxi–Out

CAUTION: Taxi at a reduced speed. Use smaller nose wheel steering wheel and rudder inputs and apply minimum thrust smoothly. Differential thrust may be used to help maintain airplane momentum during turns. At all other times, apply thrust evenly. Taxiing on slippery taxiways or runways at excessive speed or with high crosswinds may start a skid.

CAUTION: When operating the engines over significant amounts of standing de-icing or anti-icing fluid, limit thrust to the minimum required. Excessive ingestion of de-icing or anti-icing fluid can cause the fluid to build up on the engine compressor blades resulting in compressor stalls and engine surges.

When engine anti-ice is required and the OAT is 3°C or below, an engine run up is recommended to minimize ice build-up. Use the following procedure:

Check that the area behind the airplane is clear. C

Run-up to a minimum of 70% N1 for approximately 30 seconds duration at intervals no greater than 30 minutes. C

Note: Fan blade ice build-up is cumulative. If the fan spinner and fan blades were not deiced prior to taxi out, the time the engines were operating during the taxi in should be included in the 30 minute interval.

If airport surface conditions and the concentration of aircraft do not allow the engine thrust level to be increased to 70% N1, then set a thrust level as high as practical and time at that thrust level. C

Note: When operating in conditions of freezing rain, freezing drizzle, freezing fog or heavy snow, run-ups to a minimum of 70% N1 for approximately 1 second duration at intervals no greater than 10 minutes enhance ice shedding.

De-icing/Anti-icing

Testing of undiluted de-icing/anti-icing fluids has shown that some of the fluid remains on the wing during takeoff rotation and initial climb. The residual fluid causes a temporary decrease in lift and increase in drag, however, the effects are temporary. Use the normal takeoff rotation rate.

CAUTION: Operate the APU during de-icing only if necessary. If the APU is running, ingestion of de-icing fluid causes objectionable fumes and odors to enter the airplane. Ingestion of snow, slush, ice, or de-icing/anti-icing fluid can also cause damage to the APU.

If de-icing/anti-icing is needed:

APU .... As needed F/O

The APU should be shut down unless APU operation is necessary.

Call “FLAPS UP”. C

Flaps .... UP F/O

Prevents ice and slush from accumulating in flap cavities during de-icing.

Thrust levers .... Idle C

Reduces the possibility of injury to personnel at inlet or exhaust areas.

WARNING: Ensure that the stabilizer trim wheel handles are stowed before using electric trim to avoid personal injury.

Stabilizer trim .... ___ UNITS C

Set the trim for takeoff.

Verify that the trim is in the green band.

Engine BLEED air switches ....OFF F/O

Reduces the possibility of fumes entering the air conditioning system.

APU BLEED air switch ....OFF F/O

Reduces the possibility of fumes entering the air conditioning system.

After de-icing/anti-icing is completed:

APU .... As needed F/O

CAUTION: After de-icing, the use of APU bleed air during takeoff can cause smoke in the airplane.

APU BLEED air switch .... As needed F/O

Wait approximately one minute after de-icing is completed to turn engine BLEED air switches on to ensure all de-icing fluid has been cleared from the engines:

Engine BLEED air switches ....ON F/O

Flight controls .... Check, as needed C

An increase in control forces can be expected at low temperatures.

Before Takeoff Procedure

Do the normal Before Takeoff Procedure with the following modifications:

Call "FLAPS ___" as needed for takeoff.	PF
Flap lever .... Set takeoff flaps, as needed	PM

Extend the flaps to the takeoff setting at this time if they have been held because of slush, or standing water, or icing conditions, or because of exterior de-icing/anti-icing.

Verify that the LE FLAPS EXT green light is illuminated.

Takeoff Procedure

Do the normal Takeoff Procedure with the following modification:

When engine anti-ice is required and the OAT is 3°C or below, the takeoff must be preceded by a static engine run-up. Use the following procedure:

Run-up to a minimum of 70% N1 and confirm stable engine operation before the start of the takeoff roll. A 30-second run-up is highly recommended whenever possible.

Engine Anti-Ice Operation - In Flight

Engine anti–ice must be ON during all flight operations when icing conditions exist or are anticipated, except during climb and cruise when the temperature is below -40°C SAT. Engine anti–ice must be ON before, and during descent in all icing conditions, including temperatures below -40°C SAT.

When operating in areas of possible icing, activate engine anti–ice before entering icing conditions.

WARNING: Do not rely on airframe visual icing cues before activating engine anti–ice. Use the temperature and visible moisture criteria because late activation of engine anti-ice may allow excessive ingestion of ice and result in engine damage or failure.

CAUTION: Do not use engine anti-ice when TAT is above 10°C

When engine anti-ice is needed:

ENGINE START switches .... CONT	PM

ENGINE ANTI-ICE switches .... ON PM

Verify that the COWL VALVE OPEN lights illuminate bright, then dim.

Verify that the COWL ANTI-ICE lights are extinguished.

Note: If the COWL VALVE OPEN lights remain illuminated bright with engines at IDLE, do the following:.

- verify APU BLEED air switch is in the OFF posiiton,
- verify ISOLATION VALVE switch is in the AUTO position, and
- increase thrust slightly (up to a minimum of 30% N1).

When engine anti-ice is no longer needed:

ENGINE ANTI-ICE switches ....OFF PM

Verify that the COWL VALVE OPEN lights illuminate bright, then extinguish.

ENGINE START switches ....OFF PM

Fan Ice Removal

CAUTION: Avoid prolonged operation in moderate to severe icing conditions.

Prolonged operation in moderate to severe icing conditions can lead to fan blade/spinner icing and engine vibration. Severe icing can usually be avoided by a change in altitude and/or airspeed. If flight in moderate to severe icing conditions cannot be avoided, do the following on both engines, one engine at a time:

Note: Engine vibration can reduce to a low level before 80% N1 is reached, however, thrust increase must continue to a minimum of 80% N1 to remove ice from the fan blades.

Note: Engine vibration can indicate full scale before shedding ice, however, this has no adverse effect on the engine.

ENGINE START switches (both) ....FLT PM

Autothrottle (if engaged) .... Disengage PF

Thrust ....Increase PF

Increase thrust to a minimum of 80% N1 for approximately 1 second to ensure the fan blades and spinner are clear of ice.

Thrust .... Reduce as needed for flight conditions PF

Wait 15 seconds. This allows engine vibration level to stabilize.

If engine vibration is less than 4.0 units after thrust is reduced, repeat the above steps at approximately 15 minute intervals or sooner as needed.

Autothrottle (if needed) .... Engage PF

If engine vibration is 4.0 units or greater after thrust is reduced, do the Engine High Vibration non-normal checklist.

Wing Anti-ice Operation - In Flight

Ice accumulation on the flight deck window frames, windshield center post, or on the windshield wiper arm may be used as an indication of structural icing conditions and the need to turn on wing anti-ice.

In flight, the wing anti-ice system may be used as a de-icer or as an anti-icer. The primary method is to use it as a de-icer by allowing ice to accumulate before turning wing anti-ice on. This procedure provides the cleanest airfoil surface, the least possible runback ice formation, and the least thrust and fuel penalty. Normally it is not necessary to shed ice periodically unless extended flight through icing conditions is necessary (holding).

The secondary method is to use wing anti-ice before ice accumulation. Operate the wing anti-ice system as an anti-icer only during extended operations in moderate or severe icing conditions, such as holding.

CAUTION: Do not use wing anti-ice when TAT is above 10°C.

CAUTION: Use of wing anti-ice above approximately FL350 may cause bleed trip off and possible loss of cabin pressure.

Note: Prolonged operation in icing conditions with the leading edge and trailing edge flaps extended is not recommended. Holding in icing conditions with flaps extended is prohibited.

When wing anti-ice is needed:

WING ANTI-ICE switch .... ON PM

Verify that the L and R VALVE OPEN lights illuminate bright, then dim.

When wing anti-ice is no longer needed:

WING ANTI-ICE switch .... OFF PM

Verify that the L and R VALVE OPEN lights illuminate bright, then extinguish.

Cold Temperature Altitude Corrections

Extremely low temperatures create significant altimeter errors and greater potential for reduced terrain clearance. When the temperature is colder than ISA, true altitude will be lower than indicated altitude. Altimeter errors become significantly larger when the surface temperature approaches -30°C or colder, and also become larger with increasing height above the altimeter reference source.

Apply the altitude correction table when needed:

- apply corrections to all published minimum departure, en route and approach altitudes, including missed approach altitudes, according to the table below. Advise ATC of the corrections
- MDA/DA settings should be set at the corrected minimum altitudes for the approach
- corrections apply to QNH and QFE operations.

To determine the correction from the Altitude Correction Table:

- subtract the elevation of the altimeter barometric reference setting source (normally the departure or destination airport elevation) from the published minimum altitude to be flown to determine “height above altimeter reference source”
- if the corrected indicated altitude to be flown is between 100 foot increments, set the MCP altitude to the closest 100 foot increment above the corrected indicated altitude to be flown.
- enter the table with Airport Temperature and with “height above altimeter reference source”. Read the correction where these two entries intersect. Add the correction to the published minimum altitude to be flown to determine the corrected indicated altitude to be flown. To correct an altitude above the altitude in the last column, use linear extrapolation (e.g., to correct 6000 feet or 1800 meters, use twice the correction for 3000 feet or 900 meters, respectively.) The corrected altitude must always be greater than the published minimum altitude
- do not correct altimeter barometric reference settings.

An altitude correction due to cold temperature is not needed for the following conditions:

- While under ATC radar vectors
- When maintaining an ATC assigned flight level (FL)
- When the reported airport temperature is above 0°C or if the airport temperature is at or above the minimum published temperature for the procedure being flown.

Note: Regulatory authorities may have other requirements for cold temperature altitude corrections.

Altitude Correction Table (Heights and Altitudes in Feet)

Airport Temp °C	Height Above Altimeter Reference Source											
	200 feet	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1000 feet	1500 feet	2000 feet	3000 feet
0°	20	20	30	30	40	40	50	50	60	90	120	170
-10°	20	30	40	50	60	70	80	90	100	150	200	290
-20°	30	50	60	70	90	100	120	130	140	210	280	420
-30°	40	60	80	100	120	140	150	170	190	280	380	570
-40°	50	80	100	120	150	170	190	220	240	360	480	720
-50°	60	90	120	150	180	210	240	270	300	450	590	890

Altitude Correction Table (Heights and Altitudes in Meters)

Airport Temp °C	Height Above Altimeter Reference Source											
	60 m	90 m	120 m	150 m	180 m	210 m	240 m	270 m	300 m	450 m	600 m	900 m
0°	5	5	10	10	10	15	15	15	20	25	35	50
-10°	10	10	15	15	20	20	25	30	30	45	60	90
-20°	10	15	20	25	25	30	35	40	45	65	85	130
-30°	15	20	25	30	35	40	45	55	60	85	115	170
-40°	15	25	30	40	45	50	60	65	75	110	145	220
-50°	20	30	40	45	55	65	75	80	90	135	180	270

Approach and Landing

Use normal procedures and reference speeds.

After Landing Procedure

CAUTION: Taxi at a reduced speed. Use smaller nose wheel steering wheel and rudder inputs and apply minimum thrust smoothly. Differential thrust may be used to help maintain airplane momentum during turns. At all other times, apply thrust evenly. Taxiing on slippery taxiways or runways at excessive speed or with high crosswinds may start a skid.

CAUTION: When operating the engines over significant amounts of standing de-icing or anti-icing fluid, limit thrust to the minimum required. Excessive ingestion of de-icing or anti-icing fluid can cause the fluid to build up on the engine compressor blades resulting in compressor stalls and engine surges.

Do the normal After Landing Procedure with the following modifications:

After prolonged operation in icing conditions with the flaps extended, or when an accumulation of airframe ice is observed, or when operating on a runway or taxiway contaminated with ice, snow, slush or standing water:

Do not retract the flaps to less than flaps 15 until the flap areas have been checked to be free of contaminants.

Engine anti-ice must be selected ON and remain on during all ground operations when icing conditions exist or are anticipated.

WARNING: Do not rely on airframe visual icing cues before activating engine anti-ice. Use the temperature and visible moisture criteria because late activation of engine anti-ice may allow excessive ingestion of ice and result in engine damage or failure.

CAUTION: Do not use engine anti-ice when OAT is above 10°C.

When engine anti-ice is needed:

ENGINE START switches .... CONT F/O

ENGINE ANTI-ICE switches .... ON F/O

Verify that the COWL VALVE OPEN lights illuminate bright, then dim.

Verify that the COWL ANTI-ICE lights are extinguished.

Note: If the COWL VALVE OPEN lights remain illuminated bright with engines at IDLE, do the following:

- verify APU BLEED air switch is in the OFF posiiton,
- verify ISOLATION VALVE switch is in the AUTO position, and
- increase thrust slightly (up to a maximum of 30% N1).

When engine anti-ice is no longer needed:

ENGINE ANTI-ICE switches .... OFF F/O

Verify that the COWL VALVE OPEN lights illuminate bright, then extinguish.

ENGINE START switches .... OFF F/O

When engine anti-ice is required and the OAT is 3°C or below, an engine run up is recommended to minimize ice build-up. Use the following procedure: C

Check that the area behind the airplane is clear.

Run-up to a minimum of 70% N1 for approximately 30 seconds duration at intervals no greater than 30 minutes.

If airport surface conditions and the concentration of aircraft do not allow the engine thrust level to be increased to 70% N1, then set a thrust level as high as practical and time at that thrust level.

Note: When operating in conditions of freezing rain, freezing drizzle, freezing fog or heavy snow, run-ups to a minimum of 70% N1 for approximately 1 second duration at intervals no greater than 10 minutes should be considered.

Shutdown Procedure

Do the following step before starting the normal Shutdown Procedure:

After landing in icing conditions:

WARNING: Ensure that the stabilizer trim wheel handles are stowed before using electric trim to avoid personal injury.

Stabilizer trim .... Set 5 units C

Prevents melting snow and ice from running into the tailcone. Excessive water in the tailcone can freeze and lock controls.

Secure Procedure

Do the normal Secure Procedure with the following modifications:

If the airplane will be attended and warm air circulation throughout the cargo E/E compartments is desired:

CAUTION: Do not leave the interior unattended with a pack operating and all doors closed. With the airplane in this configuration, accidental closure of the main outflow valve can cause unscheduled pressurization of the airplane.

APU ....Start F/O

APU GENERATOR bus switches .... ON F/O

PACK switches .... AUTO F/O

ISOLATION VALVE switch............................OPEN F/O

Pressurization mode selector ....MAN F/O

Outflow valve switch ....OPEN F/O

Prevents aircraft pressurization.

Note: The airplane must be parked into the wind when the outflow valve is full open.

APU BLEED air switch .... ON F/O

If the airplane will not be attended, or if staying overnight at off-line stations or at airports where normal support is not available, the flight crew must arrange for or verify that the following steps are done:

Pressurization mode selector ....MAN F/O

Outflow valve ....CLOSE F/O

Position the outflow valve fully closed to inhibit the intake of snow or ice.

Wheel chocks ....Verify in place C or F/O

Parking brake ....Released C

Reduces the possibility of frozen brakes.

Cold weather maintenance procedures for securing the airplane may be required. These procedures are normally done by maintenance personnel, and include, but are not limited to:

- protective covers and plugs installed
- water storage containers drained
- toilets drained
- doors and sliding windows closed
- batteries removed. If the batteries will be exposed to temperatures below -18°C, the batteries should be removed and stored in an area warmer than -18°C, but below 40°C. Subsequent installation of the warm batteries ensures the starting capability of the APU.

Maximum Cooling on the Ground - APU Bleed

During ground operation the following considerations will help keep the airplane as cool as possible:

- While the airplane is electrically powered, packs should be run or cooling air supplied to the airplane when the OAT exceeds 40° C (103° F) to protect the reliability of electrical and electronic equipment in the airplane.
- If cooling air is available from an outside source, the supply should be plugged in immediately after engine shutdown and should not be removed until just prior to engine start.
- Keep all doors and windows, including cargo doors, closed as much as possible.
- Electronic components which contribute to a high temperature level in the flight deck should be turned off while not needed.
- Open all passenger cabin gasper outlets and close all window shades on the sun–exposed side of the passenger cabin.

Note: If only cooling air from a ground air conditioning cart is supplied (no pressurized air from the APU or ground external air), then the TAT probes may not be aspirated. Because of high TAT probe temperatures, the FMC's may not accept an assumed temperature derate. Delay selecting an assumed temperature derate until after bleed air is available.

If these actions do not reduce cabin temperatures sufficiently:

PASSENGER CABIN temperature
selector .... AUTO COOL

PACK switches .... HIGH

After engine start with the engines at ground idle, the pneumatic pressure available to the bleed air system may not be sufficient to provide adequate cooling during extended ground operations. Use of APU bleed air instead of engine bleed air to supply the packs while on the ground can significantly increase cabin cooling. If additional cooling is needed during extended ground operations:

Engine BLEED 1 air switch .... OFF

Engine BLEED 2 air switch .... OFF

ISOLATION VALVE switch .... OPEN

APU BLEED air switch .... ON

PACK switches ....HIGH

Temperature selectors ....AUTO COOL

Prior to takeoff:

PACK switches ....AUTO

Engine BLEED 2 air switch ....ON

APU BLEED air switch... OFF

Engine BLEED 1 air switch ....ON

ISOLATION VALVE switch ....AUTO

Temperature selectors ....As needed

Moderate to Heavy Rain, Hail or Sleet

Flights should be conducted to avoid thunderstorm or hail activity. If visible moisture is present at high altitude, avoid flight over the storm cell. (Storm cells that do not produce visible moisture at high altitude can be overflown safely.) To the maximum extent possible, moderate to heavy rain, hail or sleet should also be avoided.

If moderate to heavy rain, hail or sleet is encountered or anticipated:

ENGINE START switches ....CONT

Autothrottle ....Disengage

Thrust Levers.. Adjust Slowly

If thrust changes are necessary, move the thrust levers slowly. Avoid changing thrust lever direction until engines have stabilized at a selected setting. Maintain an increased minimum thrust setting.

IAS/MACH ....Use a slower speed

Using a slower speed improves engine tolerance to heavy precipitation intake.

Consider starting the APU (if available).

Operation in a Sandy or Dusty Environment

The main hazards of a sandy or dusty environment are erosion (especially of engine fan blades), accumulation of sand or dust on critical surfaces and blockage. The effects of sand ingestion occur predominantly during takeoff, landing and taxi operations. The adverse effects, however, can occur if the airplane's flight path was through a cloud of visible sand or dust or the airplane was parked during a sand or dust storm. Premature engine deterioration can result from sand or dust ingestion, causing increased fuel burn and reduced EGT margins.

CAUTION: After a sandstorm, if all taxiways and runways are not carefully inspected and swept for debris before flight ops are conducted, the risk of engine damage and wear is increased.

Exterior Inspection

Although removal of sand and dust contaminants is primarily a maintenance function, during the exterior inspection the captain or first officer should carefully inspect areas where accumulation of sand or dust could change or affect normal system operations.

Do the normal Exterior Inspection with the following additional steps:

Windshield .... Check

Verify that the windshield has been cleaned.

Note: Do not use windshield wipers for sand or dust removal. Wash deposits off with water and wipe residue off with a soft cloth.

Surfaces .... Check

Verify that the upper surfaces of the wings and other control surfaces are free of sand.

CAUTION: Particular care should be taken to ensure that the fuselage and all surfaces are clean after a sand storm that occurs with a rain storm.

Probes, sensors, ports, ram turbine doors,
vents, and drains (as applicable) .... Check

Verify that the left and right ram air inlets are free of sand and dust. Verify that the cabin pressure outflow valve and both positive pressure relief valves are free of sand and dust.

Leading edge flaps .... Check

Verify that all leading edges are undamaged.

Engine inlets .... Check

Verify that the inlet cowling is free of sand and dust.

Verify that the fan is free to rotate and fan blades are undamaged.

Fuel tank vents .... Check

Verify that all vents are free of sand and dust.

Landing gear .... Check

Verify that gear struts and doors are free of sand and dust build-up.

Vertical and horizontal stabilizers .... Check

Verify that all leading edges are undamaged.

APU air inlets .... Check

Ensure that the APU inlet door and cooling air inlet are free of sand and dust before APU start.

Preflight Procedure - First Officer

Do the normal Preflight Procedure - First Officer with the following modifications:

Note: Minimize the use of air conditioning, other than from a ground air conditioner, as much as possible. If the APU must be used for air conditioning, maintain a temperature as high as possible while still providing a tolerable flight deck and cabin environment.

APU BLEED air switch ....OFF F/O

If APU bleed air will be used and the APU is not operating:

APU switch ....START F/O

Note: Run the APU for one full minute before using it as a bleed air source.

Engine BLEED air switches .... OFF F/O

APU BLEED air switch ....ON F/O

Engine Start Procedure

Do the normal Engine Start Procedure with the following modifications:

Note: Use a filtered ground cart for pneumatic air for engine start, if available.

ENGINE START switch .... GRD		F/O
Verify that the N2 RPM increases.		C, F/O

Motor the engine for 2 minutes to help remove contaminants.

CAUTION: Do not apply rotational force when moving the engine start lever.

Engine start lever..IDLE detent	C

Before Taxi Procedure

Do the normal Before Taxi Procedure with special emphasis on the following steps:

If bleed air is needed to maintain tolerable flight deck and cabin temperatures, use APU bleed air rather than engine bleed air during the taxi out. Limit APU bleed air use as much as possible to reduce sand and dust ingestion.

If APU bleed air will be used and the APU is not operating:

APU switch .... START	F/O

Note: Run the APU for one full minute before using it as a bleed air source.

Engine BLEED air switches ....OFF	F/O
APU BLEED air switch .... ON	F/O
Flight controls .... Check	C

Verify that there is no increase in control forces due to sand or dust contaminants.

Taxi–Out

Do the following, conditions permitting, to minimize sand and dust ingestion by the engines and to improve visibility during taxi:

- Use all engines during taxi and taxi at low speed. Limit ground speed to 10 knots and maintain thrust below 40% N1 whenever possible to avoid creating engine vortices during ground operations.
- Maintain a greater than normal separation from other aircraft while taxiing and avoid the ingestion of another engine's wake.
- Avoid engine overhang of unprepared surfaces.

- In the event of a crosswind during 180° turns, turn away from the wind if possible to minimize sand and dust ingestion.
- Whenever possible, avoid situations that would require the airplane to be brought to a complete stop.
- Avoid excessive braking. The presence of sand or dust will increase brake wear.

Takeoff

Do the following to minimize sand and dust ingestion by the engines during takeoff:

- Use the maximum fixed derate and/or assumed temperature thrust reduction that meets performance requirements.
- Make an No Engine Bleed Takeoff if operations permit. If cabin and flight deck temperatures can be maintained at a tolerable temperature, consider an Unpressurized Takeoff.
- Before takeoff, allow sand and dust to settle if conditions allow.
- Do not take off into a sand or dust cloud.
- Use a rolling takeoff. Whenever possible, avoid setting high thrust at low speed.
- When visible sand and dust exist, consider delaying flap retraction until above the dust cloud, if operations permit.

Approach

Do the following, conditions permitting, to minimize sand and dust ingestion:

- Make an No Engine Bleed Landing if operations permit. If cabin and flight deck temperatures can be maintained at a tolerable temperature, consider an Unpressurized Landing.

Landing

Do the following to minimize sand and dust ingestion by the engines during landing:

- Use autobrakes on landing to help minimize the need for reverse thrust.
- Performance permitting, minimize the use of reverse thrust to prevent ingestion of dust and sand and to prevent reduction of visibility. Reverse thrust is most effective at high speed.

After Landing Procedure

Do the normal After Landing Procedure with the following modifications:

If bleed air is needed to maintain tolerable flight deck and cabin temperatures, use APU bleed air rather than engine bleed air during the taxi in. Limit APU bleed air use as much as possible to reduce sand and dust ingestion.

If APU bleed air will be used and the APU is not operating:

APU switch .... START PM

Note: Run the APU for one full minute before using it as a bleed air source.

Engine BLEED air switches ....OFF PM

APU BLEED air switch .... ON PM

Taxi-In

Do the following, conditions permitting, to minimize sand and dust ingestion by the engines and to improve visibility during the taxi-in:

- Use all engines and taxi at low speed. Limit ground speed to 10 knots and maintain thrust below 40% N1 whenever possible.
- Maintain a greater than normal separation from other aircraft while taxiing and avoid the ingestion of another engine's wake.
- Avoid engine overhang of unprepared surfaces.
- In the event of a crosswind during 180° turns, turn away from the wind if possible to minimize sand and dust ingestion.
- Whenever possible, avoid situations that would require the airplane to be brought to a complete stop.
- Avoid excessive braking. The presence of sand or dust will increase brake wear.

Secure Procedure

Do the normal Secure Procedure with the following modifications:

CAUTION: Do not leave the interior unattended with a pack operating and all doors closed. With the main outflow valve closed, an unscheduled pressurization of the airplane may occur.

PACK switches.. Verify OFF F/O

Pressurization mode selector...................................... MAN F/O

Outflow VALVE switch ....CLOSE F/O

Position the outflow valve fully closed to inhibit the intake of sand or dust.

Additional procedures for securing the airplane during sandy or dusty conditions may be needed. These procedures are normally done by maintenance personnel, and include, but are not limited to:

- engine covers installed, if applicable.
- protective covers and plugs installed (streamers should be used to remind personnel to remove before flight).
- doors and sliding windows closed.
- all compartments closed.

Turbulence

During flight in light to moderate turbulence, the autopilot and/or autothrottle may remain engaged unless performance is objectionable. Increased thrust lever activity can be expected when encountering wind, temperature changes and large pressure changes. Short–time airspeed excursions of 10 to 15 knots can be expected.

Passenger signs .... ON

Advise passengers to fasten seat belts prior to entering areas of reported or anticipated turbulence. Instruct the cabin crew to check that all passengers' seat belts are fastened.

Severe Turbulence

Yaw Damper .... ON

Autothrottle .... Disengage

AUTOPILOT .... CWS

A/P status annunciators display CWS for pitch and roll.

Note: If sustained trimming occurs, disengage the autopilot.

ENGINE START switches .... FLT

Thrust .... Set

Set thrust as needed for the phase of flight. Change thrust setting only if needed to modify an unacceptable speed trend.

PHASE OF FLIGHT	AIRSPEED
CLIMB	280 knots or .76 Mach whichever is lower.
CRUISE	Use FMC recommended thrust settings. If the FMC is inoperative, refer to the Unreliable Airspeed page in the Performance–Inflight section of the QRH for approximate N1 settings that maintain near optimum penetration airspeed.
DESCENT	.76 Mach/280/250 knots whichever is lower. If severe turbulence is encountered at altitudes below 15,000 feet and the airplane gross weight is less than the maximum landing weight, the airplane may be slowed to 250 knots in the clean configuration.

Note: If an approach must be made into an area of severe turbulence, delay flap extension as long as possible. The airplane can withstand higher gust loads in the clean configuration.

Windshear

Windshear is a change of wind speed and/or direction over a short distance along the flight path. Indications of windshear are listed in the Windshear non-normal maneuver in this manual.

Avoidance

The flight crew should search for any clues to the presence of windshear along the intended flight path. Presence of windshear may be indicated by:

- Thunderstorm activity
- Virga (rain that evaporates before reaching the ground)
- Pilot reports
- Low level windshear alerting system (LLWAS) warnings.

Stay clear of thunderstorm cells and heavy precipitation and areas of known windshear. If the presence of windshear is confirmed, delay takeoff or do not continue an approach.

Precautions

If windshear is suspected, be especially alert to any of the danger signals and be prepared for the possibility of an inadvertent encounter. The following precautionary actions are recommended if windshear is suspected:

Takeoff

- Takeoff with full rated takeoff thrust is recommended, unless the use of a fixed derate is required to meet a dispatch performance requirement
- For optimum takeoff performance, use flaps 5, 10 or 15 unless limited by obstacle clearance and/or climb gradient
- Use the longest suitable runway provided it is clear of areas of known windshear
- Consider increasing Vr speed to the performance limited gross weight rotation speed, not to exceed actual gross weight Vr + 20 knots. Set V speeds for the actual gross weight. Rotate at the adjusted (higher) rotation speed. This increased rotation speed results in an increased stall margin and meets takeoff performance requirements. If windshear is encountered at or beyond the actual gross weight Vr, do not attempt to accelerate to the increased Vr but rotate without hesitation
- Be alert for any airspeed fluctuations during takeoff and initial climb. Such fluctuations may be the first indication of windshear

- Know the all–engine initial climb pitch attitude. Rotate at the normal rate to this attitude for all non–engine failure takeoffs. Minimize reductions from the initial climb pitch attitude until terrain and obstruction clearance is assured, unless stick shaker activates
- Crew coordination and awareness are very important. Develop an awareness of normal values of airspeed, attitude, vertical speed, and airspeed buildup. Closely monitor vertical flight path instruments such as vertical speed and altimeters. The pilot monitoring should be especially aware of vertical flight path instruments and call out any deviations from normal
- Should airspeed fall below the trim airspeed, unusual control column forces may be required to maintain the desired pitch attitude. If stick shaker is encountered, reduce pitch attitude. Do not exceed the Pitch Limit Indication.

Approach and Landing

- Use flaps 30 for landing
- Establish a stabilized approach no lower than 1000 feet above the airport to improve windshear recognition capability
- Use the most suitable runway that avoids the areas of suspected windshear and is compatible with crosswind or tailwind limitations. Use electronic or visual glide path indications to detect flight path deviations and help with timely detection of windshear
- If the autothrottle is disengaged, or is planned to be disengaged prior to landing, add an appropriate airspeed correction (correction applied in the same manner as gust), up to a maximum of 15 knots
- Avoid large thrust reductions or trim changes in response to sudden airspeed increases as these may be followed by airspeed decreases
- Crosscheck flight director commands using vertical flight path instruments
- Crew coordination and awareness are very important, particularly at night or in marginal weather conditions. Closely monitor the vertical flight path instruments such as vertical speed, altimeters, and glideslope displacement. The pilot monitoring should call out any deviations from normal. Use of the autopilot and autothrottle for the approach may provide more monitoring and recognition time.

Recovery

Accomplish the Windshear Escape Maneuver found in the Non–Normal Maneuvers section of the QRH.

Ice Crystal Icing (ICI)

At temperatures below freezing near convective weather, the airplane can encounter visible moisture made up of high concentrations of small ice crystals. Ice crystals can accumulate aft of the engine fan in the engine core. Ice shedding can cause engine vibration, engine power loss and engine damage. CFM56-7 engines have experienced several power loss events resulting from ice accumulation in the engine.

Ice crystals can also accumulate in the fan hub. This can cause vibration indications above 4 units. Fan ice removal procedures have no effect on fan hub icing. When clear of clouds, fan hub ice sublimates and engine vibration decreases over time. Fan hub ice can remain into descent.

Ice crystal icing is difficult to detect because ice crystals do not cause significant weather radar returns. They are often found in high concentrations above and near regions of heavy precipitation. Ice crystals do not stick to cold airplane surfaces.

Avoid ICI conditions. Flight in clouds containing high concentrations of ice crystals has been associated with engine vibration, engine power loss and engine damage.

Because these conditions can be difficult to recognize, careful preflight planning is a key component of in–flight situational awareness. When ICI is encountered or suspected, do the QRH Ice Crystal Icing NNC to mitigate the effect on the flight.

Recognizing Ice Crystal Icing

Ice crystals are most frequently found in areas of visible moisture and above altitudes normally associated with icing conditions. Their presence can be indicated by one or more of the following:

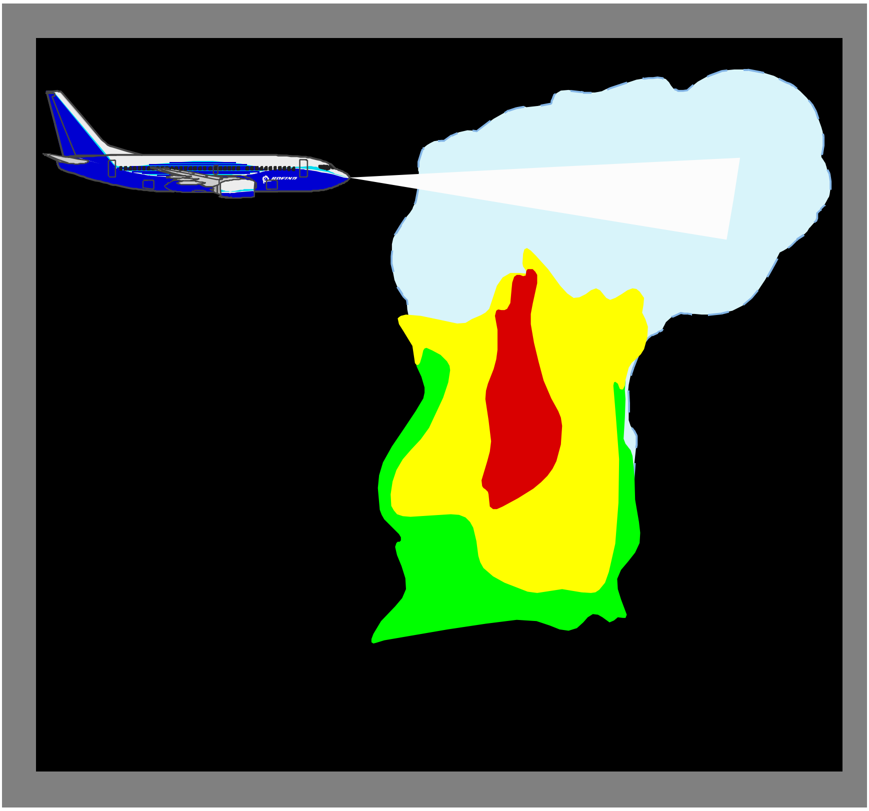
- appearance of rain on the windshield at temperatures too cold for liquid water to exist. This is due to ice crystals melting on the heated windows (sounds different than rain)
- Areas of light to moderate turbulence
- In IMC with:
  - No significant airframe icing and
  - no significant radar returns at airplane altitude and
  - heavy precipitation below the airplane, identified by amber and red radar returns on the weather radar.
- cloud tops above typical cruise levels (above the tropopause).
- Smell of ozone or sulfur

- Humidity increase
- Static discharge around the windshield (St. Elmo’s fire)

Avoiding Ice Crystal Icing

During flight in IMC, avoid flying directly over significant amber or red radar returns, even if there are no returns at airplane altitude.

Use the weather radar controls to assess weather radar reflectivity below the airplane flight path. Refer to weather radar operating instructions for additional information.



Areas with a higher risk of High Ice Water Content (HIWC) are identified by some aviation weather vendors. In these areas, ICI should be suspected while operating in IMC. Use of this type of HIWC information is recommended for strategic preflight planning and in–flight adjustments in order to avoid potential ICI conditions.

Ice Crystal Icing Suspected

If conditions allow, exit the ice crystal icing conditions laterally. Climbing or descending to exit ice crystal icing conditions is not recommended. Request a route change to minimize the time above red and amber radar returns.

Do the Ice Crystal Icing non-normal checklist.

Intentionally
Blank

Performance Inflight — Chapter PI
Table of Contents — Section 10

737-8 LEAP-1B27 KG C M FAA CATB TO1-10% TO2-20%

Performance Inflight — Chapter PI
Pkg Model Identification — Section 10

General

Performance Inflight number 10 package was chosen to represent all 737 MAX 8 EB1 27K CATB from GOL's fleet.

Intentionally
Blank

Takeoff Speeds - Dry Runway
Max Takeoff Thrust
Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
90	168	168	175	159	161	166									
85	161	163	169	155	156	162	151	153	158	149	150	155			
80	156	158	165	150	151	158	147	148	154	145	145	151	142	142	148
75	151	152	161	144	146	154	141	143	150	139	140	147	136	137	144
70	145	146	156	139	140	149	136	137	146	133	134	143	131	131	140
65	139	140	152	133	134	145	130	131	142	128	129	139	125	126	136
60	132	134	146	126	128	140	123	125	137	121	122	134	119	119	131
55	125	127	141	120	121	135	117	118	132	115	116	129	113	113	126
50	117	119	135	113	114	129	110	111	126	108	109	124	106	106	121
45	110	111	129	105	106	123	102	104	120	101	102	118	99	99	115
40	102	103	122	97	99	117	95	96	114	93	94	112	92	92	110

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	5	6	6	7	8	9	10	11	13	4	5	5	6	6	7	9	10	10	-2	-2	-2	-3	-3	-3	-4	-4	-4
50	4	5	6	7	8	9	10	11	13	3	3	5	6	6	7	9	10	10	-1	-1	-2	-3	-3	-3	-4	-4	-4
40	1	2	3	5	7	8	10	11	13	1	2	3	5	6	7	9	10	10	0	-1	-1	-2	-2	-3	-4	-4	-4
30	0	0	1	3	4	7	9	11	13	0	0	2	3	4	6	8	9	10	0	0	0	-1	-1	-2	-3	-3	-4
20	0	0	1	2	3	5	7	9	11	0	0	1	2	3	5	6	8	10	0	0	0	-1	-1	-2	-2	-3	-4
10	0	0	1	2	3	4	5	7	10	0	0	1	2	3	4	5	7	9	0	0	0	-1	-1	-1	-2	-2	-3
0	0	0	1	2	3	4	5	7	8	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-2	-2	-3
-60	2	2	2	3	4	5	6	7	9	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-2	-2	-3

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
90	-4	-2	0	2	5	-2	-2	-1	0	1	2
80	-3	-1	0	2	4	-2	-1	-1	0	1	2
70	-2	-1	0	1	2	-2	-1	-1	0	1	2
60	-2	-1	0	1	2	-2	-1	-1	0	1	2
50	-1	-1	0	1	1	-2	-1	-1	0	1	2
40	-1	-1	0	1	1	-2	-1	-1	0	1	3

***V1 not to exceed VR.**

Takeoff Speeds - Dry Runway
Max Takeoff Thrust
Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	99	96	94	91	89	86	83	79	75
55	99	96	94	91	89	86	83	79	75
50	101	99	94	91	89	86	83	79	75
45	104	102	97	92	89	86	83	79	75
40	107	104	100	95	90	86	83	79	75
35	109	107	103	98	93	87	83	79	75
30	110	109	105	101	97	90	85	80	75
25	110	109	106	102	99	92	87	82	76
20	110	110	106	103	100	94	89	84	78
15	110	110	106	103	100	96	92	86	80
10	110	110	106	103	100	97	94	89	82
5	110	110	106	103	100	97	94	90	84
0	110	110	106	103	100	97	94	90	86
-60	111	111	107	104	101	98	95	91	86

Takeoff Speeds - Wet Runway

Max Takeoff Thrust

Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
90	158	168	175	152	161	166									
85	153	163	169	146	156	162	143	153	158	141	150	155			
80	147	158	165	140	151	158	137	148	154	135	145	151	132	142	148
75	141	152	161	134	146	154	131	143	150	129	140	147	126	137	144
70	134	146	156	128	140	149	125	137	146	123	134	143	120	131	140
65	128	140	152	122	134	145	119	131	142	117	129	139	114	126	136
60	121	134	146	115	128	140	113	125	137	110	122	134	108	119	131
55	114	127	141	108	121	135	106	118	132	104	116	129	101	113	126
50	106	119	135	101	114	129	98	111	126	96	109	124	94	106	121
45	98	111	129	93	106	123	91	104	120	89	102	118	87	99	115
40	90	103	122	85	99	117	83	96	114	81	94	112	79	92	110

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	7	8	8	10	10	12	14	15	19	4	5	5	6	6	7	9	10	10	-2	-2	-2	-3	-3	-3	-4	-4	-4
50	4	5	8	10	10	12	14	15	19	3	3	5	6	6	7	9	10	10	-1	-1	-2	-3	-3	-3	-4	-4	-4
40	1	3	5	7	10	12	14	15	19	1	2	3	5	6	7	9	10	10	0	-1	-1	-2	-2	-3	-4	-4	-4
30	0	0	1	3	6	10	12	15	19	0	0	2	3	4	6	8	9	10	0	0	0	-1	-1	-2	-3	-3	-4
20	0	0	1	3	4	7	9	12	16	0	0	1	2	3	5	6	8	10	0	0	0	-1	-1	-2	-2	-3	-4
10	0	0	1	3	4	5	6	9	13	0	0	1	2	3	4	5	7	9	0	0	0	-1	-1	-1	-2	-2	-3
0	0	0	1	3	4	5	6	8	11	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-2	-2	-3
-60	2	2	3	5	6	7	8	10	12	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-2	-2	-3

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
90	-6	-3	0	3	6	-4	-2	-1	0	1	3
80	-5	-2	0	2	5	-4	-3	-1	0	2	3
70	-4	-2	0	2	4	-4	-3	-1	0	2	3
60	-3	-2	0	2	3	-4	-3	-1	0	2	3
50	-3	-1	0	1	3	-4	-3	-1	0	2	3
40	-2	-1	0	1	2	-4	-3	-1	0	2	3

***V1 not to exceed VR.**

Takeoff Speeds - Wet Runway

Max Takeoff Thrust

Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	99	96	94	91	89	86	83	79	75
55	99	96	94	91	89	86	83	79	75
50	101	99	94	91	89	86	83	79	75
45	104	102	97	92	89	86	83	79	75
40	107	104	100	95	90	86	83	79	75
35	109	107	103	98	93	87	83	79	75
30	110	109	105	101	97	90	85	80	75
25	110	109	106	102	99	92	87	82	76
20	110	110	106	103	100	94	89	84	78
15	110	110	106	103	100	96	92	86	80
10	110	110	106	103	100	97	94	89	82
5	110	110	106	103	100	97	94	90	84
0	110	110	106	103	100	97	94	90	86
-60	111	111	107	104	101	98	95	91	86

Stabilizer Trim Setting
Max Takeoff Thrust
Flaps 1 and 5

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8 1/4	7 3/4	7 1/2	7 1/4	6 3/4	6 1/2	6 1/4	5 3/4	5 1/2	5	4 3/4	4 1/4	4	3 1/2
80	8 1/2	8 1/2	8	7 3/4	7 1/2	7	6 3/4	6 1/2	6	5 3/4	5 1/4	5	4 1/2	4 1/4	3 3/4	3 1/2
70	8 1/4	8	7 1/2	7 1/4	7	6 3/4	6 1/4	6	5 1/2	5 1/4	4 3/4	4 1/2	4	3 3/4	3 1/2	3
60	7 1/2	7 1/4	7	6 3/4	6 1/4	6	5 3/4	5 1/2	5	4 3/4	4 1/4	4	3 3/4	3 1/4	3	3
50	6 3/4	6 1/4	6	5 3/4	5 1/2	5 1/4	5	4 1/2	4 1/4	4	3 1/2	3 1/4	3	3	3	3
40	5 1/4	5	4 3/4	4 1/2	4 1/4	4	3 3/4	3 1/2	3 1/4	3	3	3	3	3	3	3

Flaps 10, 15, and 25

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8	7 1/2	7	6 1/2	6	5 1/2	5 1/4	4 3/4	4 1/4	4	3 1/2	3	3	3
80	8 1/2	8 1/2	7 3/4	7 1/4	6 3/4	6 1/4	6	5 1/2	5	4 3/4	4 1/4	3 3/4	3 1/4	3	3	3
70	8 1/2	7 3/4	7 1/4	6 3/4	6 1/4	5 3/4	5 1/2	5	4 1/2	4 1/4	3 3/4	3 1/4	3	3	3	3
60	7 1/2	7	6 1/2	6	5 3/4	5 1/4	4 3/4	4 1/2	4	3 1/2	3 1/4	3	3	3	3	3
50	6	5 3/4	5 1/4	5	4 1/2	4 1/4	3 3/4	3 1/2	3 1/4	3	3	3	3	3	3	3
40	4 1/2	4 1/4	4	3 3/4	3 1/2	3 1/4	3	3	3	3	3	3	3	3	3	3

VREF

Based on 14500 ft reference pressure altitude

WEIGHT (1000 KG)	VREF (KIAS)		
	FLAPS		
	40	30	15
90	169	169	179
85	163	165	173
80	156	160	168
75	149	154	162
70	144	149	156
65	140	145	152
60	134	139	145
55	128	132	139
50	121	126	132
45	115	119	125
40	108	112	118

Flap Maneuver Speeds

FLAP POSITION	MANEUVER SPEED
UP	VREF40 + 70
1	VREF40 + 50
5	VREF40 + 30
10	VREF40 + 30
15	VREF40 + 20
25	VREF40 + 10
30	VREF30
40	VREF40

ADVISORY INFORMATION

Slush/Standing Water Takeoff

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5.9	-7.6	-9.3	-10.9	-8.2	-9.9	-11.6	-13.2	-12.4	-14.2	-15.9	-17.4
80	-5.2	-6.9	-8.7	-10.2	-6.9	-8.7	-10.4	-11.9	-10.2	-11.9	-13.6	-15.1
70	-4.2	-5.9	-7.7	-9.2	-5.4	-7.2	-8.9	-10.5	-7.7	-9.4	-11.2	-12.7
60	-3.0	-4.7	-6.4	-8.0	-3.8	-5.5	-7.2	-8.8	-5.2	-6.9	-8.6	-10.2
50	-1.5	-3.2	-4.9	-6.5	-1.9	-3.6	-5.3	-6.8	-2.5	-4.2	-5.9	-7.5
40	0.0	-1.5	-3.2	-4.7	0.0	-1.4	-3.1	-4.7	0.0	-1.5	-3.2	-4.7

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	35.4				37.9				42.4	23.7		
1400	59.6	39.2	18.8		61.7	41.6	21.6		64.6	45.8	27.0	
1600	84.5	63.5	42.9	24.5	85.7	65.3	45.2	27.2	87.0	68.1	49.2	32.4
1800	109.6	88.4	67.3	48.7	109.8	89.4	69.1	50.9	109.4	90.5	71.5	54.5
2000		113.7	92.3	73.2		113.7	93.1	74.7			93.9	76.8
2200				98.3				98.9				99.3

1. **Enter Table 1 with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-13	-8	-3	0	-10	-5	0	0	-2	0	0	0
80	-15	-10	-5	0	-12	-7	-2	0	-4	0	0	0
70	-16	-11	-6	-2	-13	-8	-3	0	-7	-2	0	0
60	-18	-13	-8	-3	-16	-11	-6	-1	-10	-5	0	0
50	-20	-15	-10	-5	-18	-13	-8	-4	-15	-10	-5	0
40	-23	-18	-13	-8	-22	-17	-12	-8	-20	-15	-10	-6

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff
No Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8.1	-9.8	-11.6	-13.2	-10.6	-12.3	-14.1	-15.6	-15.1	-16.9	-18.6	-20.2
80	-7.3	-9.0	-10.8	-12.4	-9.2	-10.9	-12.7	-14.2	-12.6	-14.3	-16.1	-17.6
70	-6.2	-7.9	-9.7	-11.3	-7.6	-9.3	-11.1	-12.6	-9.9	-11.6	-13.4	-15.0
60	-4.8	-6.6	-8.3	-9.9	-5.7	-7.4	-9.2	-10.8	-7.1	-8.8	-10.6	-12.1
50	-3.1	-4.9	-6.6	-8.2	-3.5	-5.3	-7.0	-8.6	-4.1	-5.9	-7.6	-9.2
40	-1.0	-2.8	-4.5	-6.1	-1.1	-2.9	-4.6	-6.2	-1.0	-2.8	-4.5	-6.1

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1400									29.5			
1500					26.2				45.6			
1600	35.2				47.2				60.8	36.3		
1700	58.6	22.2			66.2	34.9			75.2	52.0	27.1	
1800	78.4	45.2			83.0	55.5	24.3		88.7	66.9	42.8	
1900	95.4	67.6	30.7		98.2	73.7	43.9		101.7	81.0	58.5	36.0
2000		85.7	55.4	19.8		89.5	63.5	35.0		94.1	72.9	51.9
2100		101.7	75.3	45.2		105.2	80.3	55.2			86.5	66.8
2200			92.4	66.9			95.5	73.2			99.9	80.7
2300				85.3				89.2				94.0
2400				101.8				104.0				

1. **Enter Table 1 with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -35 m/+35 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-18	-13	-8	-4	-14	-9	-4	0	-4	0	0	0
80	-20	-15	-10	-5	-16	-11	-6	-2	-6	-1	0	0
70	-22	-17	-12	-8	-19	-14	-9	-4	-10	-5	0	0
60	-25	-20	-15	-11	-22	-17	-12	-8	-15	-10	-5	-1
50	-28	-23	-18	-14	-26	-21	-16	-12	-22	-17	-12	-7
40	-32	-27	-22	-18	-31	-26	-21	-17	-29	-24	-19	-14

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

ADVISORY INFORMATION

Dry Snow Takeoff

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4.4	-5.8	-7.0	-8.2	-6.2	-7.5	-8.8	-10.0	-9.6	-10.8	-12.2	-13.3
80	-4.4	-5.7	-7.0	-8.2	-5.8	-7.1	-8.3	-9.5	-8.3	-9.6	-10.9	-12.1
70	-3.9	-5.2	-6.5	-7.7	-4.9	-6.2	-7.5	-8.7	-6.8	-8.0	-9.3	-10.5
60	-3.0	-4.3	-5.6	-6.8	-3.7	-5.0	-6.3	-7.4	-4.9	-6.2	-7.5	-8.7
50	-1.7	-2.9	-4.3	-5.4	-2.0	-3.3	-4.6	-5.8	-2.8	-4.0	-5.4	-6.5
40	0.0	-1.2	-2.5	-3.6	0.0	-1.2	-2.5	-3.7	-0.3	-1.6	-2.9	-4.0

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	39.0	19.0			42.6	23.7			46.6	29.6		
1400	63.7	43.6	23.5		65.9	46.9	28.0		67.8	50.4	33.4	
1600	88.7	68.3	48.1	30.1	89.4	70.2	51.2	34.1	89.5	71.8	54.3	38.9
1800	113.6	93.2	72.9	54.7	113.0	93.7	74.5	57.3	111.5	93.5	75.7	60.0
2000			97.9	79.5			98.1	80.7			97.6	81.4
2200				104.6				104.5				103.5

1. **Enter Table 1 with dry snow depth and dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-10	-5	0	0	-7	-2	0	0	-2	0	0	0
80	-12	-7	-2	0	-9	-4	0	0	-4	0	0	0
70	-14	-9	-4	0	-12	-7	-2	0	-7	-2	0	0
60	-17	-12	-7	-2	-14	-9	-4	0	-10	-5	0	0
50	-19	-14	-9	-5	-17	-12	-7	-3	-13	-8	-3	0
40	-22	-17	-12	-8	-20	-15	-10	-6	-17	-12	-7	-2

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Dry Snow Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6.4	-7.6	-8.8	-9.8	-8.2	-9.4	-10.6	-11.7	-11.5	-12.7	-13.9	-15.0
80	-6.4	-7.6	-8.8	-9.9	-7.8	-9.0	-10.2	-11.3	-10.3	-11.6	-12.7	-13.8
70	-6.0	-7.2	-8.4	-9.4	-6.9	-8.1	-9.3	-10.4	-8.8	-10.0	-11.2	-12.2
60	-5.0	-6.2	-7.4	-8.5	-5.6	-6.8	-8.0	-9.1	-6.8	-8.0	-9.2	-10.3
50	-3.4	-4.7	-5.9	-6.9	-3.8	-5.0	-6.2	-7.3	-4.4	-5.6	-6.8	-7.9
40	-1.4	-2.6	-3.8	-4.9	-1.5	-2.7	-3.9	-5.0	-1.5	-2.8	-3.9	-5.0

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1300									33.0			
1400					31.4				45.9			
1500	36.1				48.8				58.7	38.8		
1600	56.9	22.9			65.0	39.2			71.4	51.7	31.6	
1700	75.5	45.1			80.1	56.1	30.2		83.9	64.4	44.5	
1800	91.8	65.8	32.5		94.3	71.9	46.9		96.2	77.0	57.4	39.4
1900		83.2	55.2	23.2		86.6	63.5	40.1		89.4	70.1	52.3
2000		98.4	73.9	46.8		100.3	78.6	57.0		101.6	82.5	65.0
2100			89.9	66.5			92.7	72.5			94.8	77.6
2200			105.6	83.7				87.1				89.9
2300				99.7				101.2				102.2

1. **Enter Table 1 with dry snow depth and dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-13	-8	-3	0	-9	-4	0	0	-2	0	0	0
80	-16	-11	-6	-1	-13	-8	-3	0	-6	-1	0	0
70	-20	-15	-10	-5	-16	-11	-6	-2	-10	-5	0	0
60	-24	-19	-14	-9	-20	-15	-10	-6	-14	-9	-4	0
50	-28	-23	-18	-13	-25	-20	-15	-10	-19	-14	-9	-4
40	-32	-27	-22	-18	-29	-24	-19	-15	-24	-19	-14	-10

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

ADVISORY INFORMATION

Wet Snow Takeoff
Maximum Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4.4	-5.8	-7.1	-8.3	-6.2	-7.6	-8.9	-10.2	-11.5	-12.9	-14.2	-15.5
80	-4.4	-5.8	-7.2	-8.4	-5.8	-7.2	-8.5	-9.8	-9.9	-11.2	-12.6	-13.8
70	-4.0	-5.4	-6.7	-7.9	-5.0	-6.4	-7.7	-8.9	-7.8	-9.2	-10.6	-11.8
60	-3.0	-4.4	-5.8	-7.0	-3.6	-5.0	-6.4	-7.6	-5.5	-6.8	-8.2	-9.4
50	-1.6	-2.9	-4.3	-5.5	-1.9	-3.2	-4.6	-5.8	-2.7	-4.1	-5.4	-6.7
40	0.0	-1.0	-2.4	-3.6	0.0	-1.0	-2.3	-3.5	0.0	-1.0	-2.4	-3.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	37.3	17.3			39.5	20.1			43.8	26.1		
1400	62.3	42.2	22.2		63.9	44.3	25.0		66.1	48.3	30.5	
1600	88.0	67.5	47.3	29.3	88.5	68.8	49.2	31.8	88.6	70.5	52.7	36.7
1800	113.7	93.2	72.5	54.3	113.2	93.4	73.7	56.0	111.1	93.0	75.0	58.9
2000			98.3	79.7			98.4	80.6			97.6	81.3
2200				105.5				105.3				103.9

1. **Enter Table 1 with wet snow depth and dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-10	-5	0	0	-7	-2	0	0	-1	0	0	0
80	-13	-8	-3	0	-10	-5	0	0	-2	0	0	0
70	-15	-10	-5	-1	-12	-7	-2	0	-5	0	0	0
60	-17	-12	-7	-3	-15	-10	-5	-1	-9	-4	0	0
50	-20	-15	-10	-6	-19	-14	-9	-4	-14	-9	-4	0
40	-24	-19	-14	-10	-23	-18	-13	-9	-21	-16	-11	-6

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Wet Snow Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6.4	-7.6	-8.8	-10.0	-8.3	-9.5	-10.8	-11.9	-13.8	-15.1	-16.3	-17.4
80	-6.5	-7.8	-9.0	-10.1	-7.9	-9.2	-10.4	-11.5	-12.2	-13.4	-14.6	-15.7
70	-6.1	-7.3	-8.6	-9.7	-7.0	-8.3	-9.5	-10.6	-10.0	-11.2	-12.4	-13.6
60	-5.1	-6.3	-7.5	-8.6	-5.6	-6.8	-8.0	-9.2	-7.4	-8.7	-9.9	-11.0
50	-3.4	-4.7	-5.9	-7.0	-3.7	-4.9	-6.1	-7.2	-4.4	-5.6	-6.8	-8.0
40	-1.3	-2.5	-3.7	-4.8	-1.2	-2.4	-3.6	-4.8	-1.0	-2.2	-3.4	-4.5

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1400									36.4			
1500	25.6				37.4				52.4	28.0		
1600	50.8				58.4	26.5			67.4	44.3		
1700	72.4	38.0			76.4	47.8			81.3	59.9	36.0	
1800	90.0	62.4	24.3		92.1	67.8	36.6		94.7	74.4	52.1	30.1
1900	105.5	81.7	51.3	14.4		84.5	58.5	28.5		87.9	67.2	46.6
2000		97.7	72.4	42.3		99.2	76.3	51.2		100.7	81.2	62.0
2100			89.6	64.9			91.7	70.1			94.2	76.2
2200			106.2	83.6				86.3				89.5
2300				100.6				101.6				102.6

1. **Enter Table 1 with wet snow depth and dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -35 m/+35 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-13	-8	-3	0	-9	-4	0	0	-2	0	0	0
80	-17	-12	-7	-2	-13	-8	-3	0	-3	0	0	0
70	-21	-16	-11	-6	-17	-12	-7	-2	-7	-2	0	0
60	-24	-19	-14	-10	-21	-16	-11	-7	-13	-8	-3	0
50	-29	-24	-19	-15	-27	-22	-17	-13	-21	-16	-11	-6
40	-35	-30	-25	-21	-34	-29	-24	-19	-31	-26	-21	-16

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

ADVISORY INFORMATION

Slippery Runway Takeoff

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-1.1	-1.8	-2.6	-3.3	-3.1	-3.8	-4.6	-5.3	-10.3	-11.1	-11.8	-12.5
80	-1.1	-1.9	-2.6	-3.3	-3.3	-4.1	-4.8	-5.5	-9.7	-10.5	-11.2	-11.9
70	-0.8	-1.5	-2.3	-3.0	-3.1	-3.9	-4.6	-5.3	-8.6	-9.3	-10.1	-10.8
60	-0.2	-0.9	-1.7	-2.4	-2.4	-3.2	-3.9	-4.6	-6.9	-7.7	-8.4	-9.1
50	0.0	-0.8	-1.5	-2.2	-1.3	-2.1	-2.8	-3.5	-4.8	-5.5	-6.3	-6.9
40	0.0	-0.7	-1.5	-2.2	0.0	-0.7	-1.4	-2.1	-2.0	-2.8	-3.5	-4.2

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	67.4	44.6	20.9		35.7							
1400	97.9	78.2	56.6	35.3	61.3	40.6	20.1					
1600		107.9	88.2	69.8	87.6	66.3	45.5	27.0				
1800			118.1	100.3	114.1	92.7	71.3	52.5	33.2			
2000							97.8	78.5	44.3			
2200								105.1	56.1	37.3		
2400									69.0	48.7		
2600									83.1	60.9	41.6	
2800									99.0	74.2	53.2	36.4
3000										89.0	65.7	47.7
3200										105.4	79.6	59.8
3400											94.9	73.0
3600												87.7
3800												103.9

1. **Enter Table 1 with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -25 m/+25 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -30 m/+30 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -60 m/+60 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8	-6	-3	-1	-12	-10	-7	-5	-32	-30	-27	-25
80	-10	-7	-5	-2	-14	-12	-9	-7	-36	-34	-31	-29
70	-11	-8	-6	-3	-17	-14	-12	-9	-40	-37	-35	-32
60	-12	-9	-7	-4	-19	-17	-14	-12	-43	-40	-38	-35
50	-12	-10	-7	-5	-22	-19	-17	-14	-45	-43	-40	-38
40	-13	-11	-8	-6	-24	-22	-19	-17	-47	-44	-42	-40

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Slippery Runway Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-2.5	-3.1	-3.7	-4.3	-4.9	-5.5	-6.2	-6.7	-14.2	-14.8	-15.4	-16.0
80	-2.5	-3.1	-3.7	-4.3	-5.3	-5.9	-6.5	-7.1	-13.4	-14.0	-14.6	-15.2
70	-2.1	-2.8	-3.4	-3.9	-5.1	-5.8	-6.4	-6.9	-11.9	-12.6	-13.2	-13.7
60	-1.4	-2.0	-2.6	-3.1	-4.4	-5.0	-5.6	-6.2	-9.8	-10.5	-11.1	-11.6
50	-0.2	-0.9	-1.5	-2.0	-3.1	-3.7	-4.4	-4.9	-7.1	-7.7	-8.3	-8.8
40	0.0	-0.6	-1.2	-1.8	-1.3	-1.9	-2.5	-3.1	-3.7	-4.3	-4.9	-5.4

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	36.0											
1300	66.2	27.6										
1400	85.9	59.2	16.6									
1500	101.9	80.6	49.9	12.4	17.8							
1600		97.2	75.0	44.5	45.4							
1700			92.5	71.6	70.0	28.9						
1800				89.8	88.6	57.7	15.2					
1900				106.0	105.6	79.0	43.1					
2000						96.2	68.3	31.5				
2100							87.3	59.5				
2200							104.3	80.5				
2300								98.1				
3700									73.8			
3800									90.7			
4100										84.0		
4200										99.1		
4400											75.8	
4500											91.9	
4700												73.5
4800												90.3

1. **Enter Table 1 with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -30 m/+30 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -35 m/+35 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -85 m/+85 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Slippery Runway Takeoff
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-11	-6	-1	0	-16	-11	-6	-1	-50	-45	-40	-35
80	-13	-8	-3	0	-19	-14	-9	-5	-57	-52	-47	-42
70	-14	-9	-4	0	-23	-18	-13	-8	-63	-58	-53	-49
60	-15	-10	-5	-1	-27	-22	-17	-12	-69	-64	-59	-55
50	-17	-12	-7	-2	-31	-26	-21	-16	-75	-70	-65	-60
40	-18	-13	-8	-3	-35	-30	-25	-21	-80	-75	-70	-66

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

Takeoff %N1

Max Takeoff Thrust

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	85.6	86.1	86.6	86.7	86.2	85.7	85.2	84.8	84.3	83.9	83.5	83.0	82.5	81.6	80.6	79.5	78.6	78.2
55	86.9	87.3	87.7	87.8	87.4	86.9	86.4	85.9	85.5	85.1	84.6	84.2	83.7	82.7	81.8	80.7	79.8	79.4
50	88.0	88.6	89.2	88.8	88.4	88.0	87.5	87.1	86.6	86.2	85.8	85.3	84.8	83.9	83.0	81.9	81.0	80.6
45	88.9	89.5	90.0	89.9	89.5	88.9	88.6	88.2	87.7	87.3	86.9	86.4	86.0	85.0	84.1	83.0	82.2	81.7
40	89.9	90.4	91.0	90.9	90.9	90.6	89.9	89.1	88.7	88.3	88.0	87.5	87.0	86.1	85.2	84.1	83.3	82.8
35	90.7	91.3	91.9	91.9	91.8	91.7	91.6	91.3	90.7	89.7	88.9	88.5	88.1	87.2	86.3	85.3	84.4	84.0
30	90.2	91.5	92.8	92.6	92.6	92.6	92.5	92.4	92.4	92.2	89.8	89.5	89.1	88.2	87.4	86.4	85.6	85.2
25	89.4	90.7	92.0	92.3	92.7	92.8	92.9	93.2	93.0	93.0	90.8	90.4	90.0	89.2	88.4	87.6	86.7	86.3
20	88.6	89.9	91.2	91.5	91.8	92.1	92.5	92.8	93.0	93.1	91.7	91.3	91.0	90.2	89.5	88.7	87.9	87.5
15	87.8	89.1	90.4	90.7	91.0	91.3	91.6	91.9	92.3	92.6	92.7	92.4	92.0	91.2	90.5	89.8	89.0	88.7
10	87.0	88.3	89.6	89.9	90.2	90.5	90.8	91.1	91.5	91.8	92.2	92.6	93.0	92.2	91.6	90.9	90.2	89.9
5	86.2	87.5	88.8	89.1	89.4	89.7	90.0	90.3	90.7	91.0	91.4	91.8	92.2	92.2	92.2	92.0	91.4	91.1
0	85.4	86.7	87.9	88.3	88.6	88.9	89.2	89.5	89.8	90.2	90.6	91.0	91.4	91.4	91.5	91.5	91.5	91.6
-5	84.6	85.8	87.1	87.4	87.8	88.0	88.3	88.7	89.0	89.4	89.8	90.2	90.5	90.6	90.7	90.7	90.7	90.8
-10	83.8	85.0	86.3	86.6	86.9	87.2	87.5	87.8	88.1	88.5	88.9	89.3	89.7	89.8	89.8	89.9	89.9	89.9
-15	83.0	84.2	85.5	85.8	86.1	86.3	86.6	86.9	87.3	87.7	88.1	88.5	88.9	89.0	89.0	89.1	89.1	89.1
-20	82.2	83.4	84.6	84.9	85.2	85.5	85.7	86.1	86.4	86.8	87.3	87.7	88.1	88.1	88.2	88.2	88.3	88.3
-25	81.4	82.6	83.8	84.1	84.4	84.7	84.9	85.2	85.6	86.0	86.4	86.8	87.2	87.3	87.4	87.4	87.4	87.5
-30	80.5	81.8	83.0	83.3	83.6	83.8	84.1	84.4	84.7	85.1	85.5	86.0	86.4	86.5	86.5	86.6	86.6	86.6
-35	79.7	80.9	82.1	82.4	82.7	83.0	83.2	83.5	83.9	84.3	84.7	85.1	85.5	85.6	85.6	85.7	85.8	85.8
-40	78.9	80.1	81.2	81.6	81.8	82.1	82.4	82.7	83.0	83.4	83.8	84.2	84.6	84.7	84.7	84.8	84.9	84.9
-45	78.0	79.2	80.4	80.7	81.0	81.2	81.5	81.8	82.1	82.5	82.9	83.3	83.7	83.8	83.8	83.9	84.0	84.0
-50	77.2	78.3	79.5	79.8	80.1	80.3	80.6	80.9	81.3	81.6	82.0	82.4	82.7	82.8	82.9	83.0	83.1	83.2

%N1 Adjustment for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.2	1.4	1.6	1.7	1.8
ENGINE ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6

Assumed Temperature Reduced Thrust
Maximum Assumed Temperature (Table 1 of 3)
Based on 25% Takeoff Thrust Reduction

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	87	87	87	87	87	87	87	86	84	83	82				74	71	68	67
55	81	82	82	82	82	82	82	82	82	82	82				74	71	68	67
50	77	77	77	78	77	77	77	77	77	77	77	77	77		74	71	68	67
45	73	73	72	73	73	73	73	72	72	72	72	72	72	72	72	71	68	67
40	68	68	68	68	67	67	67	68	68	68	68	67	67	67	67	67	67	67
35	64	64	63	64	63	62	61	60	61	62	63	63	63	62	62	62	62	62
30	63	61	59	60	58	57	56	55	54	53	58	58	58	58	58	58	57	57
25	63	61	59	58	56	54	53	51	50	49	54	53	53	53	53	53	53	53
20	63	62	59	58	56	54	52	49	48	46	49	49	49	48	48	48	48	48
15	63	62	59	59	57	54	52	50	48	46	44	44	44	43	43	43	43	42
10	64	62	59	59	57	54	52	50	48	46	43	41	39	38	38	37	37	37
5	64	62	59	59	57	54	52	50	48	46	43	41	39	37	34	32	32	32
0	64	62	59	59	57	54	52	50	48	46	43	41	39	37	34	32	29	28
-5 & BELOW	64	62	59	59	57	54	52	50	48	46	43	41	39	37	34	32	29	28

Takeoff %N1 (Table 2 of 3)
Based on engine bleed for packs on and engine anti-ice off

ASSUMED TEMP (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
75	81.9	82.4	83.0	83.1	82.6	82.1	81.6	81.1	80.7	80.2	79.8	79.3	78.8	77.8	77.0	76.6	76.5	76.4
70	83.2	83.7	84.2	84.3	83.8	83.3	82.8	82.4	81.9	81.5	81.0	80.6	80.1	79.1	78.2	77.0	76.1	75.8
65	84.4	84.9	85.4	85.5	85.0	84.5	84.1	83.6	83.2	82.7	82.3	81.8	81.3	80.3	79.4	78.3	77.4	77.0
60	85.6	86.1	86.6	86.7	86.2	85.7	85.2	84.8	84.3	83.9	83.5	83.0	82.5	81.6	80.6	79.5	78.6	78.2
55	86.9	87.3	87.7	87.8	87.4	86.9	86.4	85.9	85.5	85.1	84.6	84.2	83.7	82.7	81.8	80.7	79.8	79.4
50	88.0	88.6	89.2	88.8	88.4	88.0	87.5	87.1	86.6	86.2	85.8	85.3	84.8	83.9	83.0	81.9	81.0	80.6
45	88.9	89.5	90.0	89.9	89.5	88.9	88.6	88.2	87.7	87.3	86.9	86.4	86.0	85.0	84.1	83.0	82.2	81.7
40	89.9	90.4	91.0	90.9	90.9	90.6	89.9	89.1	88.7	88.3	88.0	87.5	87.0	86.1	85.2	84.1	83.3	82.8
35	90.7	91.3	91.9	91.9	91.8	91.7	91.6	91.3	90.7	89.7	88.9	88.5	88.1	87.2	86.3	85.3	84.4	84.0
30	90.2	91.5	92.8	92.6	92.6	92.6	92.5	92.4	92.4	92.2	89.8	89.5	89.1	88.2	87.4	86.4	85.6	85.2
25	89.4	90.7	92.0	92.3	92.7	92.8	92.9	93.2	93.0	93.0	90.8	90.4	90.0	89.2	88.4	87.6	86.7	86.3
20	88.6	89.9	91.2	91.5	91.8	92.1	92.5	92.8	93.0	93.1	91.7	91.3	91.0	90.2	89.5	88.7	87.9	87.5
15	87.8	89.1	90.4	90.7	91.0	91.3	91.6	91.9	92.3	92.6	92.7	92.4	92.0	91.2	90.5	89.8	89.0	88.7
10	87.0	88.3	89.6	89.9	90.2	90.5	90.8	91.1	91.5	91.8	92.2	92.6	93.0	92.2	91.6	90.9	90.2	89.9
5	86.2	87.5	88.8	89.1	89.4	89.7	90.0	90.3	90.7	91.0	91.4	91.8	92.2	92.2	92.2	92.0	91.4	91.1
0	85.4	86.7	87.9	88.3	88.6	88.9	89.2	89.5	89.8	90.2	90.6	91.0	91.4	91.4	91.5	91.5	91.5	91.6
-5	84.6	85.8	87.1	87.4	87.8	88.0	88.3	88.7	89.0	89.4	89.8	90.2	90.5	90.6	90.7	90.7	90.7	90.8
-20	82.2	83.4	84.6	84.9	85.2	85.5	85.7	86.1	86.4	86.8	87.3	87.7	88.1	88.1	88.2	88.2	88.3	88.3
-40	78.9	80.1	81.2	81.6	81.8	82.1	82.4	82.7	83.0	83.4	83.8	84.2	84.6	84.7	84.7	84.8	84.9	84.9
MINIMUM ASSUMED TEMP (°C)	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	1

Assumed Temperature Reduced Thrust
%N1 Adjustment for Temperature Difference (Table 3 of 3)

ASSUMED TEMP MINUS OAT (°C)	OUTSIDE AIR TEMPERATURE (°C)													
	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
115	8.5													
110	8.5													
105	8.5													
100	7.4													
95	5.6	8.9												
90	4.2	8.9												
85	2.8	8.9												
80	1.4	7.6												
75	0.1	5.9	9.2											
70	0.0	4.4	9.2	9.2										
65	0.0	2.9	8.6	8.6	8.5									
60	0.0	1.4	8.0	8.0	8.0	7.9								
55	0.0	0.0	6.1	7.4	7.4	7.3	7.2							
50	0.0	0.0	4.5	6.2	6.8	6.8	6.6	6.4						
45	0.0	0.0	3.0	4.6	6.2	6.1	6.0	5.8	5.7					
40	0.0	0.0	1.5	3.1	4.7	5.5	5.4	5.2	5.1	4.9				
35		0.0	0.0	1.6	3.1	4.8	4.8	4.6	4.5	4.4	4.2			
30		0.0	0.0	0.1	1.6	3.2	4.1	4.0	3.9	3.8	3.7	3.6		
25		0.0	0.0	0.0	0.1	1.6	3.3	3.4	3.3	3.2	3.1	3.0	2.9	
20		0.0	0.0	0.0	0.0	0.1	1.7	2.7	2.7	2.6	2.5	2.4	2.4	2.3
15			0.0	0.0	0.0	0.0	0.2	1.8	2.0	2.0	1.9	1.8	1.8	1.7
10			0.0	0.0	0.0	0.0	0.0	0.2	1.4	1.3	1.3	1.2	1.2	1.2
5			0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.7	0.6	0.6	0.6	0.6
0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1. **Determine Maximum Assumed Temperature allowed from Table 1.**
2. **Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).**
3. **Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.**
4. **Subtract %N1 adjustment from Maximum %N1 in Table 2.**

TO1 Takeoff Speeds - Dry Runway

10% Thrust Reduction

Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
80	159	160	165	153	153	158									
75	154	154	160	148	148	153	144	144	150	141	141	147			
70	148	148	156	142	142	149	138	139	146	136	136	143	133	133	139
65	142	142	151	136	136	144	132	133	141	130	130	138	127	127	135
60	135	135	146	129	130	139	126	127	136	124	124	133	121	121	130
55	128	128	140	122	123	134	119	120	131	117	117	128	115	115	125
50	120	121	134	115	116	128	112	113	125	110	110	123	108	108	120
45	113	113	128	107	108	122	105	105	120	103	103	117	101	101	115
40	104	105	121	100	100	116	97	98	113	95	96	111	93	93	109

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	4	5	6	7	8	9	10	11	13	4	5	5	6	6	7	9	10	10	-1	-2	-2	-3	-3	-3	-4	-4	-4
50	3	3	5	7	8	9	10	11	13	3	3	4	6	6	7	9	10	10	-1	-1	-2	-2	-3	-3	-4	-4	-4
40	1	2	3	5	7	8	10	11	13	1	2	3	4	6	7	9	10	10	0	-1	-1	-2	-2	-3	-3	-4	-4
30	0	0	1	3	4	7	8	11	13	0	0	2	3	4	6	8	9	10	0	0	0	-1	-1	-2	-3	-3	-3
20	0	0	1	2	3	5	7	9	10	0	0	1	2	3	5	6	8	10	0	0	0	-1	-1	-2	-2	-3	-3
10	0	0	1	2	3	4	5	7	9	0	0	1	2	3	4	5	6	9	0	0	0	-1	-1	-1	-2	-2	-3
0	0	0	1	2	3	4	5	6	8	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-2	-2	-2
-60	1	0	1	3	3	4	5	6	8	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-2	-2	-2

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
80	-3	-2	0	2	2	-1	-1	-1	0	1	1
70	-2	-1	0	1	1	-2	-1	-1	0	1	1
60	-2	-1	0	1	1	-2	-1	-1	0	1	1
50	-1	-1	0	1	1	-2	-1	-1	0	1	1
40	-1	-1	0	1	1	-2	-1	-1	0	1	1

***V1 not to exceed VR.**

TO1 Takeoff Speeds - Dry Runway
10% Thrust Reduction
Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	94	92	90	87	84	82	79	75	71
55	94	92	90	87	84	82	79	75	71
50	96	94	90	87	84	82	79	75	71
45	99	96	92	88	84	82	79	75	71
40	101	99	95	90	85	82	79	75	71
35	103	101	97	93	88	83	79	75	71
30	104	104	99	95	92	85	81	76	71
25	104	104	101	97	94	87	83	78	72
20	104	104	101	98	95	89	85	80	74
15	104	104	101	98	95	92	87	82	76
10	104	104	101	98	95	92	89	84	78
5	104	104	101	98	95	92	89	86	80
0	104	104	101	98	95	92	89	86	82
-60	105	105	102	99	96	93	90	86	82

TO1 Takeoff Speeds - Wet Runway

10% Thrust Reduction

Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
80	151	160	165	145	153	158									
75	145	154	160	138	148	153	135	144	150	133	141	147			
70	138	148	156	132	142	149	129	139	146	127	136	143	124	133	139
65	131	142	151	126	136	144	123	133	141	121	130	138	118	127	135
60	124	135	146	119	130	139	116	127	136	114	124	133	111	121	130
55	117	128	140	112	123	134	109	120	131	107	117	128	104	115	125
50	109	121	134	104	116	128	102	113	125	100	110	123	97	108	120
45	101	113	128	96	108	122	94	105	120	92	103	117	90	101	115
40	93	105	121	88	100	116	86	98	113	84	96	111	82	93	109

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	7	8	8	10	10	12	14	15	16	4	5	5	6	6	7	9	10	10	-1	-2	-2	-3	-3	-3	-4	-4	-4
50	4	5	7	10	10	12	14	15	16	3	3	4	6	6	7	9	10	10	-1	-1	-2	-2	-3	-3	-4	-4	-4
40	1	2	4	7	9	12	14	15	16	1	2	3	4	6	7	9	10	10	0	-1	-1	-2	-2	-3	-3	-4	-4
30	0	0	1	3	5	9	11	15	16	0	0	2	3	4	6	8	9	10	0	0	0	-1	-1	-2	-3	-3	-3
20	0	0	1	3	4	6	9	12	16	0	0	1	2	3	5	6	8	10	0	0	0	-1	-1	-2	-2	-3	-3
10	0	0	1	3	4	5	7	9	13	0	0	1	2	3	4	5	6	9	0	0	0	-1	-1	-1	-2	-2	-3
0	0	0	1	3	4	5	7	8	11	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-2	-2	-2
-60	3	2	3	4	6	7	8	10	12	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-2	-2	-2

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
80	-5	-3	0	3	5	-3	-2	-1	0	1	3
70	-4	-2	0	2	4	-4	-2	-1	0	1	3
60	-3	-2	0	2	4	-4	-3	-1	0	2	3
50	-3	-1	0	1	3	-4	-3	-1	0	2	3
40	-2	-1	0	1	2	-4	-3	-1	0	2	3

***V1 not to exceed VR.**

TO1 Takeoff Speeds - Wet Runway
10% Thrust Reduction
Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	94	92	90	87	84	82	79	75	71
55	94	92	90	87	84	82	79	75	71
50	96	94	90	87	84	82	79	75	71
45	99	96	92	88	84	82	79	75	71
40	101	99	95	90	85	82	79	75	71
35	103	101	97	93	88	83	79	75	71
30	104	104	99	95	92	85	81	76	71
25	104	104	101	97	94	87	83	78	72
20	104	104	101	98	95	89	85	80	74
15	104	104	101	98	95	92	87	82	76
10	104	104	101	98	95	92	89	84	78
5	104	104	101	98	95	92	89	86	80
0	104	104	101	98	95	92	89	86	82
-60	105	105	102	99	96	93	90	86	82

TO1 Stabilizer Trim Setting
10% Thrust Reduction
Flaps 1 and 5

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8 1/2	8 1/4	7 3/4	7 1/2	7 1/4	6 3/4	6 1/2	6	5 3/4	5 1/2	5	4 3/4	4 1/4	4
80	8 1/2	8 1/2	8 1/2	8 1/4	7 3/4	7 1/2	7	6 3/4	6 1/2	6	5 3/4	5 1/4	5	4 1/2	4 1/4	3 3/4
70	8 1/2	8 1/2	8 1/4	7 3/4	7 1/2	7 1/4	6 3/4	6 1/2	6	5 3/4	5 1/4	5	4 1/2	4 1/4	3 3/4	3 1/2
60	8 1/4	8	7 3/4	7 1/4	7	6 3/4	6 1/4	6	5 3/4	5 1/4	5	4 1/2	4 1/4	3 3/4	3 1/2	3 1/4
50	7 1/2	7 1/4	7	6 3/4	6 1/4	6	5 3/4	5 1/4	5	4 3/4	4 1/4	4	3 1/2	3 1/4	3	3
40	6 1/2	6 1/4	5 3/4	5 1/2	5 1/4	5	4 3/4	4 1/4	4	3 3/4	3 1/2	3 1/4	3	3	3	3

Flaps 10, 15, and 25

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8 1/4	7 3/4	7 1/4	6 3/4	6 1/2	6	5 1/2	5 1/4	4 3/4	4 1/4	3 3/4	3 1/2	3	3
80	8 1/2	8 1/2	8 1/4	7 3/4	7 1/4	6 3/4	6 1/4	6	5 1/2	5	4 3/4	4 1/4	3 3/4	3 1/4	3	3
70	8 1/2	8 1/4	7 3/4	7 1/4	6 3/4	6 1/4	6	5 1/2	5 1/4	4 3/4	4 1/4	3 3/4	3 1/2	3	3	3
60	8 1/4	7 3/4	7 1/4	6 3/4	6 1/4	5 3/4	5 1/2	5	4 3/4	4 1/4	3 3/4	3 1/2	3	3	3	3
50	7	6 3/4	6 1/4	5 3/4	5 1/2	5	4 3/4	4 1/4	4	3 1/2	3 1/4	3	3	3	3	3
40	5 1/2	5 1/4	5	4 1/2	4 1/4	4	3 1/2	3 1/4	3 1/4	3	3	3	3	3	3	3

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

10% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6.4	-8.2	-9.9	-11.4	-8.8	-10.5	-12.2	-13.7	-13.2	-14.9	-16.6	-18.2
80	-5.6	-7.3	-9.1	-10.6	-7.4	-9.2	-10.9	-12.4	-10.8	-12.5	-14.2	-15.8
70	-4.6	-6.3	-8.0	-9.6	-5.9	-7.6	-9.3	-10.9	-8.3	-10.0	-11.7	-13.3
60	-3.2	-4.9	-6.7	-8.2	-4.1	-5.8	-7.5	-9.1	-5.6	-7.3	-9.1	-10.6
50	-1.6	-3.3	-5.0	-6.6	-2.0	-3.8	-5.5	-7.0	-2.8	-4.5	-6.3	-7.8
40	0.0	-1.5	-3.2	-4.7	0.0	-1.5	-3.2	-4.8	0.0	-1.6	-3.3	-4.9

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	45.1	23.7			47.4	26.4			51.3	31.6		
1400	70.8	49.0	27.6		72.4	51.2	30.2		74.8	54.9	35.2	
1600	97.2	74.9	53.0	33.6	97.9	76.4	55.1	36.1	98.3	78.4	58.5	40.7
1800		101.3	78.9	59.1		101.8	80.3	61.1		101.9	82.0	64.1
2000			105.2	85.2			105.6	86.3			105.6	87.6
2200				111.7				111.8				111.3

1. **Enter Table 1 with slush/standing water depth and TO1 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-11	-6	-1	0	-7	-2	0	0	0	0	0	0
80	-13	-8	-3	0	-10	-5	0	0	-1	0	0	0
70	-14	-9	-4	0	-12	-7	-2	0	-4	0	0	0
60	-16	-11	-6	-2	-14	-9	-4	0	-8	-3	0	0
50	-18	-13	-8	-4	-17	-12	-7	-2	-13	-8	-3	0
40	-22	-17	-12	-7	-21	-16	-11	-6	-19	-14	-9	-4

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff
10% Thrust Reduction
No Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8.3	-10.0	-11.7	-13.3	-10.8	-12.6	-14.3	-15.9	-15.7	-17.4	-19.2	-20.7
80	-7.5	-9.3	-11.0	-12.6	-9.5	-11.2	-13.0	-14.6	-13.1	-14.8	-16.6	-18.1
70	-6.4	-8.2	-9.9	-11.5	-7.8	-9.6	-11.3	-12.9	-10.4	-12.1	-13.9	-15.4
60	-5.0	-6.8	-8.5	-10.1	-5.9	-7.7	-9.4	-11.0	-7.5	-9.3	-11.0	-12.6
50	-3.3	-5.0	-6.8	-8.3	-3.8	-5.5	-7.3	-8.8	-4.4	-6.2	-7.9	-9.5
40	-1.2	-2.9	-4.7	-6.2	-1.3	-3.0	-4.8	-6.4	-1.3	-3.0	-4.8	-6.4

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1300									29.9			
1400					28.6				47.6			
1500	40.8				51.7				64.1	37.5		
1600	64.9	25.9			71.6	38.4			79.4	54.4	27.1	
1700	85.3	50.9			89.1	60.2	26.3		94.0	70.5	44.4	
1800	103.5	74.0	35.5		105.5	79.2	47.7			85.6	61.3	37.0
1900		93.3	61.8	23.8		96.2	68.7	38.1		99.9	77.0	54.3
2000			82.3	51.5			86.4	60.3			91.6	70.4
2100			100.1	73.7			102.6	79.0				85.4
2200				92.6				95.8				100.2

1. **Enter Table 1 with slush/standing water depth and TO1 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -35 m/+35 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-15	-10	-5	0	-10	-5	0	0	0	0	0	0
80	-17	-12	-7	-3	-13	-8	-3	0	-2	0	0	0
70	-20	-15	-10	-5	-16	-11	-6	-1	-6	-1	0	0
60	-23	-18	-13	-8	-20	-15	-10	-5	-12	-7	-2	0
50	-26	-21	-16	-12	-24	-19	-14	-10	-19	-14	-9	-4
40	-30	-25	-20	-16	-29	-24	-19	-15	-27	-22	-17	-12

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff
10% Thrust Reduction
Maximum Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4.1	-5.4	-6.7	-7.9	-6.0	-7.3	-8.6	-9.7	-9.6	-10.9	-12.2	-13.3
80	-4.3	-5.6	-6.9	-8.1	-5.8	-7.0	-8.3	-9.5	-8.4	-9.8	-11.0	-12.2
70	-4.0	-5.3	-6.6	-7.8	-5.1	-6.4	-7.7	-8.8	-7.0	-8.3	-9.6	-10.8
60	-3.2	-4.5	-5.8	-7.0	-3.9	-5.3	-6.5	-7.7	-5.3	-6.5	-7.8	-9.0
50	-2.0	-3.3	-4.6	-5.8	-2.4	-3.7	-5.0	-6.2	-3.2	-4.5	-5.8	-6.9
40	-0.3	-1.6	-2.9	-4.0	-0.4	-1.7	-3.0	-4.1	-0.8	-2.1	-3.4	-4.5

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	47.5	27.0			50.6	31.2			53.8	36.4		
1400	72.8	52.1	31.7		74.4	55.0	35.6		75.7	57.8	40.3	24.6
1600	98.4	77.6	56.8	38.3	98.6	78.9	59.3	41.9	98.0	79.7	61.8	46.0
1800		103.1	82.2	63.6		103.1	83.3	65.7		102.2	83.8	67.6
2000			107.8	89.0			107.5	89.7			106.3	89.8
2200				114.5				113.9				112.1

1. **Enter Table 1 with dry snow depth and TO1 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8	-3	0	0	-5	0	0	0	0	0	0	0
80	-10	-5	0	0	-7	-2	0	0	-2	0	0	0
70	-13	-8	-3	0	-10	-5	0	0	-5	0	0	0
60	-15	-10	-5	-1	-13	-8	-3	0	-8	-3	0	0
50	-18	-13	-8	-4	-16	-11	-6	-1	-12	-7	-2	0
40	-21	-16	-11	-6	-19	-14	-9	-4	-15	-10	-5	-1

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5.9	-7.0	-8.3	-9.3	-7.8	-9.0	-10.2	-11.2	-11.2	-12.5	-13.7	-14.7
80	-6.2	-7.3	-8.6	-9.7	-7.6	-8.8	-10.0	-11.1	-10.3	-11.5	-12.7	-13.8
70	-5.9	-7.1	-8.3	-9.4	-7.0	-8.2	-9.4	-10.5	-8.9	-10.2	-11.3	-12.4
60	-5.1	-6.3	-7.5	-8.6	-5.8	-7.0	-8.2	-9.3	-7.1	-8.3	-9.5	-10.6
50	-3.8	-4.9	-6.2	-7.2	-4.1	-5.3	-6.5	-7.6	-4.8	-6.0	-7.2	-8.3
40	-1.8	-3.0	-4.2	-5.3	-1.9	-3.1	-4.3	-5.4	-2.0	-3.3	-4.4	-5.5

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200									31.3			
1300					29.5				44.6			
1400	33.8				47.8				57.9	37.1		
1500	56.5	20.3			64.7	37.8			71.1	50.6	29.7	
1600	75.7	44.1			80.2	55.4	27.8		84.0	63.8	43.1	
1700	92.4	65.4	31.0		94.9	71.7	45.6		96.8	76.8	56.4	37.8
1800		83.5	54.2	21.2		86.9	62.8	38.5		89.7	69.6	51.2
1900		99.5	74.1	45.6		101.3	78.7	56.3		102.5	82.6	64.4
2000			90.8	66.6			93.4	72.6			95.4	77.5
2100				84.2				87.6				90.3
2200				100.1				102.4				

1. **Enter Table 1 with dry snow depth and TO1 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-10	-5	0	0	-6	-1	0	0	0	0	0	0
80	-13	-8	-3	0	-10	-5	0	0	-3	0	0	0
70	-17	-12	-7	-2	-13	-8	-3	0	-7	-2	0	0
60	-21	-16	-11	-7	-18	-13	-8	-3	-11	-6	-1	0
50	-25	-20	-15	-11	-22	-17	-12	-8	-16	-11	-6	-2
40	-30	-25	-20	-16	-27	-22	-17	-12	-22	-17	-12	-7

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff
10% Thrust Reduction
Maximum Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5.0	-6.4	-7.8	-9.0	-6.8	-8.2	-9.6	-10.8	-12.3	-13.7	-15.1	-16.3
80	-4.9	-6.3	-7.7	-8.9	-6.4	-7.8	-9.1	-10.3	-10.6	-11.9	-13.3	-14.5
70	-4.4	-5.8	-7.1	-8.3	-5.4	-6.8	-8.1	-9.3	-8.4	-9.8	-11.2	-12.4
60	-3.3	-4.6	-6.0	-7.2	-3.9	-5.3	-6.7	-7.9	-5.9	-7.3	-8.6	-9.8
50	-1.7	-3.0	-4.4	-5.6	-2.0	-3.4	-4.7	-5.9	-3.0	-4.4	-5.7	-6.9
40	0.0	-0.9	-2.3	-3.5	0.0	-0.9	-2.3	-3.5	0.0	-1.1	-2.4	-3.7

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	46.0	25.3			47.9	28.0			51.5	33.3		
1400	71.9	51.1	30.5		73.0	52.9	33.0		74.5	56.1	37.8	21.5
1600	98.4	77.2	56.2	37.7	98.5	78.1	58.0	40.0	97.7	79.1	60.7	44.2
1800		103.7	82.5	63.5		103.5	83.2	65.0		102.3	83.7	67.1
2000			108.9	89.9			108.6	90.3			106.9	90.2
2200				116.2								

1. **Enter Table 1 with wet snow depth and TO1 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8	-3	0	0	-5	0	0	0	0	0	0	0
80	-11	-6	-1	0	-8	-3	0	0	0	0	0	0
70	-13	-8	-3	0	-10	-5	0	0	-3	0	0	0
60	-16	-11	-6	-1	-13	-8	-3	0	-7	-2	0	0
50	-19	-14	-9	-4	-17	-12	-7	-3	-12	-7	-2	0
40	-23	-18	-13	-9	-22	-17	-12	-8	-20	-15	-10	-5

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff
10% Thrust Reduction
No Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6.4	-7.6	-8.8	-9.9	-8.4	-9.6	-10.8	-11.9	-14.2	-15.4	-16.6	-17.7
80	-6.6	-7.8	-9.0	-10.2	-8.1	-9.3	-10.5	-11.6	-12.5	-13.7	-15.0	-16.1
70	-6.2	-7.4	-8.7	-9.8	-7.2	-8.4	-9.7	-10.8	-10.4	-11.6	-12.8	-14.0
60	-5.3	-6.5	-7.7	-8.8	-5.9	-7.1	-8.3	-9.4	-7.8	-9.1	-10.3	-11.4
50	-3.6	-4.9	-6.1	-7.2	-3.9	-5.1	-6.4	-7.4	-4.8	-6.0	-7.3	-8.4
40	-1.4	-2.6	-3.9	-5.0	-1.4	-2.6	-3.9	-4.9	-1.4	-2.6	-3.8	-4.9

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1300									34.6			
1400	23.2				36.0				51.6	25.9		
1500	50.8				58.1	23.8			67.1	43.1		
1600	72.7	37.1			76.7	47.0			81.6	59.2	34.4	
1700	90.9	62.0	22.7		93.0	67.6	35.3		95.3	74.3	51.1	28.7
1800		82.2	50.0			85.0	57.8	26.7		88.4	66.8	45.2
1900		99.2	72.9	41.0		100.5	76.7	50.5		101.8	81.5	61.4
2000			90.8	65.4			92.7	70.4			95.0	76.4
2100				84.4				87.1				90.2
2200				102.7				103.3				

1. **Enter Table 1 with wet snow depth and TO1 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -35 m/+35 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-10	-5	0	0	-6	-1	0	0	0	0	0	0
80	-14	-9	-4	0	-10	-5	0	0	0	0	0	0
70	-18	-13	-8	-3	-14	-9	-4	0	-4	0	0	0
60	-22	-17	-12	-7	-19	-14	-9	-4	-10	-5	0	0
50	-27	-22	-17	-12	-25	-20	-15	-10	-18	-13	-8	-4
40	-33	-28	-23	-19	-32	-27	-22	-17	-28	-23	-18	-14

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-0.8	-1.5	-2.3	-2.9	-2.5	-3.2	-4.0	-4.7	-9.6	-10.3	-11.1	-11.8
80	-1.0	-1.8	-2.5	-3.2	-3.0	-3.7	-4.5	-5.2	-9.3	-10.1	-10.8	-11.5
70	-0.9	-1.6	-2.4	-3.1	-3.0	-3.8	-4.5	-5.2	-8.4	-9.2	-9.9	-10.6
60	-0.4	-1.1	-1.9	-2.6	-2.5	-3.3	-4.0	-4.7	-7.0	-7.8	-8.5	-9.2
50	0.0	-0.8	-1.5	-2.2	-1.5	-2.3	-3.0	-3.7	-5.0	-5.8	-6.5	-7.2
40	0.0	-0.8	-1.5	-2.2	-0.1	-0.9	-1.6	-2.3	-2.4	-3.2	-3.9	-4.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	79.2	56.6	31.7	8.6	45.3	23.6						
1400	111.1	90.0	68.5	47.2	72.4	50.4	28.8					
1600		122.2	100.2	81.6	100.3	77.8	55.6	36.1				
1800				112.5		105.7	83.1	63.1	39.1			
2000							111.0	90.7	51.1	31.7		
2200									64.1	43.5		
2400									78.6	55.9	36.2	
2600									94.9	69.3	48.0	30.7
2800										84.5	60.8	42.5
3000										101.4	74.8	54.8
3200											90.6	68.2
3400												83.1
3600												99.9

1. **Enter Table 1 with reported braking action and TO1 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -25 m/+25 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -30 m/+30 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -60 m/+60 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8	-5	-3	0	-11	-9	-6	-4	-29	-27	-24	-22
80	-9	-6	-4	-1	-13	-11	-8	-6	-33	-30	-28	-26
70	-10	-7	-5	-2	-15	-13	-10	-8	-36	-34	-31	-29
60	-11	-8	-6	-3	-17	-15	-12	-10	-39	-36	-34	-32
50	-11	-9	-6	-4	-20	-17	-15	-12	-41	-39	-36	-34
40	-12	-9	-7	-5	-22	-19	-17	-15	-43	-40	-38	-36

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-2.3	-2.9	-3.5	-4.1	-4.3	-4.9	-5.5	-6.0	-13.4	-14.0	-14.6	-15.1
80	-2.4	-3.1	-3.7	-4.3	-4.9	-5.5	-6.1	-6.7	-12.9	-13.5	-14.1	-14.7
70	-2.2	-2.9	-3.4	-4.0	-4.9	-5.5	-6.2	-6.7	-11.7	-12.3	-13.0	-13.5
60	-1.6	-2.2	-2.8	-3.4	-4.4	-5.0	-5.6	-6.2	-9.8	-10.5	-11.1	-11.6
50	-0.5	-1.1	-1.8	-2.3	-3.3	-3.9	-4.5	-5.0	-7.3	-7.9	-8.5	-9.0
40	0.0	-0.6	-1.2	-1.8	-1.5	-2.1	-2.7	-3.3	-3.9	-4.6	-5.2	-5.8

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	64.2	18.2										
1300	85.4	56.1	5.7									
1400	103.1	80.1	47.1		17.4							
1500		98.0	73.8	40.1	48.0							
1600			92.9	70.1	73.2	31.0						
1700				89.8	92.3	60.8	14.7					
1800				107.9		82.4	45.7					
1900						100.2	71.5	33.4				
2000							90.9	62.7				
2100								83.8				
2200								102.5				
3500									79.6			
3600									95.5			
3800										69.2		
3900										89.0		
4000										102.9		
4200											81.3	
4300											97.3	
4500												79.1
4600												95.6

1. **Enter Table 1 with reported braking action and TO1 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -30 m/+30 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -35 m/+35 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -85 m/+85 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-10	-5	0	0	-14	-9	-4	0	-45	-40	-35	-31
80	-11	-6	-1	0	-17	-12	-7	-3	-51	-46	-41	-37
70	-13	-8	-3	0	-21	-16	-11	-6	-57	-52	-47	-43
60	-14	-9	-4	0	-24	-19	-14	-10	-63	-58	-53	-48
50	-15	-10	-5	0	-28	-23	-18	-13	-68	-63	-58	-54
40	-16	-11	-6	-1	-32	-27	-22	-17	-73	-68	-63	-58

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

TO1 Takeoff %N1

10% Thrust Reduction

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	81.9	82.4	82.9	83.0	82.5	82.0	81.6	81.1	80.7	80.3	79.8	79.4	78.9	78.0	77.1	76.0	75.5	75.5
55	83.3	83.6	84.1	84.1	83.7	83.2	82.7	82.3	81.9	81.4	81.0	80.6	80.1	79.1	78.2	77.2	76.3	75.9
50	84.3	84.9	85.5	85.1	84.8	84.3	83.8	83.4	83.0	82.5	82.1	81.7	81.2	80.3	79.4	78.3	77.5	77.0
45	85.2	85.8	86.3	86.1	85.7	85.2	84.9	84.5	84.1	83.6	83.2	82.8	82.3	81.4	80.5	79.4	78.6	78.2
40	86.1	86.7	87.2	87.2	87.1	86.8	86.2	85.4	85.1	84.7	84.3	83.9	83.4	82.5	81.6	80.5	79.7	79.3
35	86.9	87.6	88.1	88.1	88.0	87.9	87.8	87.5	86.9	86.0	85.2	84.8	84.4	83.5	82.7	81.7	80.8	80.4
30	86.5	87.7	89.0	88.8	88.8	88.8	88.7	88.6	88.5	88.3	86.1	85.8	85.4	84.6	83.7	82.8	82.0	81.6
25	85.7	87.0	88.2	88.5	88.9	89.0	89.0	89.3	89.2	89.2	87.0	86.6	86.3	85.5	84.7	83.9	83.1	82.7
20	84.9	86.2	87.4	87.7	88.0	88.3	88.6	88.9	89.1	89.2	87.9	87.6	87.2	86.5	85.7	85.0	84.2	83.8
15	84.2	85.4	86.6	86.9	87.2	87.5	87.8	88.1	88.5	88.8	88.9	88.5	88.2	87.4	86.7	86.0	85.3	85.0
10	83.4	84.7	85.9	86.1	86.4	86.7	87.1	87.4	87.7	88.0	88.4	88.8	89.1	88.4	87.8	87.2	86.5	86.1
5	82.7	83.9	85.1	85.4	85.7	86.0	86.3	86.6	86.9	87.2	87.6	88.0	88.3	88.3	88.4	88.2	87.6	87.3
0	81.9	83.1	84.3	84.6	84.9	85.2	85.5	85.8	86.1	86.5	86.8	87.2	87.6	87.6	87.7	87.7	87.7	87.8
-5	81.1	82.3	83.5	83.8	84.1	84.4	84.7	85.0	85.3	85.6	86.0	86.4	86.8	86.8	86.9	86.9	87.0	87.0
-10	80.3	81.5	82.7	83.0	83.3	83.6	83.8	84.2	84.5	84.8	85.2	85.6	86.0	86.1	86.1	86.2	86.2	86.2
-15	79.6	80.7	81.9	82.2	82.5	82.8	83.0	83.3	83.7	84.0	84.4	84.9	85.2	85.3	85.3	85.4	85.4	85.4
-20	78.8	80.0	81.1	81.4	81.7	82.0	82.2	82.5	82.8	83.2	83.6	84.1	84.4	84.5	84.5	84.6	84.6	84.6
-25	78.0	79.2	80.3	80.6	80.9	81.2	81.4	81.7	82.0	82.4	82.8	83.2	83.6	83.7	83.7	83.8	83.8	83.8
-30	77.2	78.4	79.5	79.8	80.1	80.4	80.6	80.9	81.2	81.6	82.0	82.4	82.8	82.9	82.9	83.0	83.0	83.0
-35	76.4	77.6	78.7	79.0	79.3	79.5	79.8	80.1	80.4	80.8	81.2	81.6	81.9	82.0	82.1	82.2	82.2	82.2
-40	75.6	76.8	77.9	78.2	78.5	78.7	79.0	79.3	79.6	79.9	80.3	80.7	81.1	81.2	81.2	81.3	81.4	81.4
-45	74.8	75.9	77.1	77.3	77.6	77.9	78.1	78.4	78.7	79.1	79.5	79.9	80.2	80.3	80.4	80.5	80.5	80.6
-50	74.0	75.1	76.2	76.5	76.8	77.0	77.3	77.6	77.9	78.2	78.6	79.0	79.3	79.4	79.5	79.6	79.7	79.7

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.2	1.4	1.6	1.7	1.8
ENGINE ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.6	-0.6	-0.6	-0.5	0.0	0.0

TO1 Assumed Temperature Reduced Thrust

Maximum Assumed Temperature (Table 1 of 3)

Based on 25% Takeoff Thrust Reduction

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	78	80	81	81	80	79	77	76	75	73	72	71	69	67	64	61	60	59
55	78	80	81	81	80	79	77	76	75	73	72	71	69	67	64	61	59	57
50	77	77	77	78	77	77	77	76	75	73	72	71	69	67	64	61	59	57
45	72	72	72	73	73	73	73	72	72	72	72	71	69	67	64	61	59	57
40	68	68	68	68	67	67	67	68	68	68	67	67	67	67	64	61	59	57
35	64	64	64	64	63	62	61	60	61	62	63	63	63	62	62	62	59	58
30	63	61	59	60	59	57	56	55	54	53	58	58	58	58	58	57	57	57
25	63	62	59	59	56	54	53	51	50	49	54	54	54	53	53	53	53	53
20	64	62	59	59	57	54	52	50	48	46	49	49	49	49	48	48	48	48
15	64	62	59	59	57	54	52	50	48	46	44	44	44	43	43	43	43	43
10	64	62	60	59	57	54	52	50	48	46	43	41	39	38	38	38	37	37
5	64	62	60	59	57	54	52	50	48	46	43	41	39	37	34	32	32	32
0	64	62	60	59	57	54	52	50	48	46	43	41	39	37	34	32	29	28
-5 & BELOW	64	62	60	59	57	54	52	50	48	46	43	41	39	37	34	32	29	28

Takeoff %N1 (Table 2 of 3)

Based on engine bleed for packs on and engine anti-ice off

ASSUMED TEMP (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
75	78.3	78.8	79.3	79.4	78.9	78.4	78.0	77.5	77.1	77.1	77.1	77.1	77.1	77.1	77.0	76.6	76.5	76.4
70	79.5	80.0	80.6	80.6	80.2	79.7	79.2	78.7	78.3	77.8	77.4	77.0	76.6	76.6	76.6	76.6	76.1	75.8
65	80.7	81.2	81.8	81.8	81.4	80.9	80.4	79.9	79.5	79.1	78.7	78.2	77.7	76.8	76.0	76.0	76.0	76.0
60	81.9	82.4	82.9	83.0	82.5	82.0	81.6	81.1	80.7	80.3	79.8	79.4	78.9	78.0	77.1	76.0	75.5	75.5
55	83.3	83.6	84.1	84.1	83.7	83.2	82.7	82.3	81.9	81.4	81.0	80.6	80.1	79.1	78.2	77.2	76.3	75.9
50	84.3	84.9	85.5	85.1	84.8	84.3	83.8	83.4	83.0	82.5	82.1	81.7	81.2	80.3	79.4	78.3	77.5	77.0
45	85.2	85.8	86.3	86.1	85.7	85.2	84.9	84.5	84.1	83.6	83.2	82.8	82.3	81.4	80.5	79.4	78.6	78.2
40	86.1	86.7	87.2	87.2	87.1	86.8	86.2	85.4	85.1	84.7	84.3	83.9	83.4	82.5	81.6	80.5	79.7	79.3
35	86.9	87.6	88.1	88.1	88.0	87.9	87.8	87.5	86.9	86.0	85.2	84.8	84.4	83.5	82.7	81.7	80.8	80.4
30	86.5	87.7	89.0	88.8	88.8	88.8	88.7	88.6	88.5	88.3	86.1	85.8	85.4	84.6	83.7	82.8	82.0	81.6
25	85.7	87.0	88.2	88.5	88.9	89.0	89.0	89.3	89.2	89.2	87.0	86.6	86.3	85.5	84.7	83.9	83.1	82.7
20	84.9	86.2	87.4	87.7	88.0	88.3	88.6	88.9	89.1	89.2	87.9	87.6	87.2	86.5	85.7	85.0	84.2	83.8
15	84.2	85.4	86.6	86.9	87.2	87.5	87.8	88.1	88.5	88.8	88.9	88.5	88.2	87.4	86.7	86.0	85.3	85.0
10	83.4	84.7	85.9	86.1	86.4	86.7	87.1	87.4	87.7	88.0	88.4	88.8	89.1	88.4	87.8	87.2	86.5	86.1
5	82.7	83.9	85.1	85.4	85.7	86.0	86.3	86.6	86.9	87.2	87.6	88.0	88.3	88.3	88.4	88.2	87.6	87.3
0	81.9	83.1	84.3	84.6	84.9	85.2	85.5	85.8	86.1	86.5	86.8	87.2	87.6	87.6	87.7	87.7	87.7	87.8
-5	81.1	82.3	83.5	83.8	84.1	84.4	84.7	85.0	85.3	85.6	86.0	86.4	86.8	86.8	86.9	86.9	87.0	87.0
-20	78.8	80.0	81.1	81.4	81.7	82.0	82.2	82.5	82.8	83.2	83.6	84.1	84.4	84.5	84.5	84.6	84.6	84.6
-40	75.6	76.8	77.9	78.2	78.5	78.7	79.0	79.3	79.6	79.9	80.3	80.7	81.1	81.2	81.2	81.3	81.4	81.4
MINIMUM ASSUMED TEMP (°C)	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	1

TO1 Assumed Temperature Reduced Thrust
%N1 Adjustment for Temperature Difference (Table 3 of 3)

ASSUMED TEMP MINUS OAT (°C)	OUTSIDE AIR TEMPERATURE (°C)													
	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
115	8.3													
110	8.3													
105	8.3													
100	7.2													
95	5.5	8.6												
90	4.1	8.6												
85	2.7	8.6												
80	1.4	7.4												
75	0.1	5.7	9.0											
70	0.0	4.2	8.8	8.8										
65	0.0	2.8	8.3	8.2	8.2									
60	0.0	1.4	7.7	7.7	7.6	7.6								
55	0.0	0.0	5.9	7.1	7.1	7.0	6.9							
50	0.0	0.0	4.4	6.0	6.5	6.5	6.3	6.1						
45	0.0	0.0	2.9	4.5	5.9	5.9	5.7	5.6	5.4					
40	0.0	0.0	1.4	3.0	4.5	5.3	5.2	5.0	4.9	4.7				
35		0.0	0.0	1.5	3.0	4.6	4.6	4.4	4.3	4.2	4.1			
30		0.0	0.0	0.1	1.5	3.1	4.0	3.8	3.7	3.6	3.5	3.4		
25		0.0	0.0	0.0	0.1	1.6	3.1	3.2	3.1	3.1	3.0	2.9	1.9	
20		0.0	0.0	0.0	0.0	0.1	1.6	2.6	2.5	2.5	2.4	2.3	1.9	0.2
15			0.0	0.0	0.0	0.0	0.2	1.7	1.9	1.9	1.8	1.8	1.7	0.2
10			0.0	0.0	0.0	0.0	0.0	0.2	1.3	1.3	1.2	1.2	1.2	0.2
5			0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.6	0.6	0.6	0.2
0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1. **Determine Maximum Assumed Temperature allowed from Table 1.**
2. **Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).**
3. **Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.**
4. **Subtract %N1 adjustment from Maximum %N1 in Table 2.**

TO2 Takeoff Speeds - Dry Runway

20% Thrust Reduction

Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
70	150	150	155	144	144	148	140	140	144	138	138	142			
65	144	144	150	138	138	143	134	134	140	132	132	137	129	129	135
60	137	137	145	131	131	138	128	128	135	126	126	132	123	123	130
55	130	130	139	124	124	133	121	121	130	119	119	127	117	117	125
50	123	123	133	117	117	127	114	114	124	112	112	122	110	110	119
45	115	115	127	110	110	121	107	107	119	105	105	116	103	103	114
40	106	106	120	102	102	115	99	99	112	97	97	110	95	95	108

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	4	5	6	6	6	7	9	10	10	4	5	5	6	6	7	9	10	10	-2	-2	-2	-3	-3	-3	-4	-4	-4
50	2	3	4	5	6	7	9	10	10	3	3	4	5	6	7	9	10	10	-1	-1	-1	-2	-3	-3	-4	-4	-4
40	1	2	3	4	6	7	9	10	10	1	2	3	4	6	7	9	10	10	0	0	-1	-1	-2	-2	-3	-4	-4
30	0	0	2	3	4	6	7	10	10	0	0	2	3	4	6	7	9	10	0	0	0	-1	-1	-2	-2	-2	-4
20	0	0	1	2	3	5	7	8	10	0	0	1	2	3	5	6	8	10	0	0	0	-1	-1	-1	-2	-2	-4
10	0	0	1	2	3	4	5	6	9	0	0	1	2	3	4	5	6	9	0	0	0	-1	-1	-1	-1	-2	-2
0	0	0	1	2	3	4	5	6	7	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-1	-1	-2
-60	0	0	1	2	3	4	5	6	7	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-1	-1	-2

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)											
	SLOPE (%)					WIND (KTS)						
	-2	-1	0	1	2	-15	-10	-5	0	20	40
70	-3	-2	0	0	0	-1	0	0	0	0	0
60	-2	-1	0	0	0	-2	-1	-1	0	0	0
50	-1	-1	0	0	0	-2	-1	-1	0	0	0
40	-1	-1	0	0	0	-2	-1	-1	0	0	0

***V1 not to exceed VR.**

TO2 Takeoff Speeds - Dry Runway
20% Thrust Reduction
Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	89	87	85	82	80	77	75	71	68
55	89	87	85	82	80	77	75	71	68
50	91	89	85	82	80	77	75	71	68
45	93	91	87	83	80	77	75	71	68
40	96	94	90	85	81	77	75	71	68
35	98	96	92	88	84	79	75	71	68
30	98	98	94	90	87	81	77	72	68
25	98	98	95	92	88	82	78	74	68
20	98	98	95	92	89	84	80	76	70
15	98	98	95	92	89	86	82	77	72
10	98	98	95	92	89	87	84	80	74
5	98	98	95	92	90	87	84	81	76
0	98	98	95	92	90	87	84	81	77
-60	99	99	96	93	90	87	85	82	77

TO2 Takeoff Speeds - Wet Runway

20% Thrust Reduction

Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
70	142	150	155	136	144	148	133	140	144	132	138	142			
65	135	144	150	130	138	143	127	134	140	125	132	137	122	129	135
60	128	137	145	123	131	138	120	128	135	118	126	132	115	123	130
55	121	130	139	116	124	133	113	121	130	111	119	127	108	117	125
50	113	123	133	108	117	127	106	114	124	103	112	122	101	110	119
45	105	115	127	100	110	121	98	107	119	96	105	116	94	103	114
40	97	106	120	92	102	115	90	99	112	88	97	110	86	95	108

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	6	7	7	9	10	11	13	13	13	4	5	5	6	6	7	9	10	10	-2	-2	-2	-3	-3	-3	-4	-4	-4
50	3	4	7	9	10	11	13	13	13	3	3	4	5	6	7	9	10	10	-1	-1	-1	-2	-3	-3	-4	-4	-4
40	1	2	4	6	9	11	13	13	13	1	2	3	4	6	7	9	10	10	0	0	-1	-1	-2	-2	-3	-4	-4
30	0	0	1	3	5	9	11	11	11	0	0	2	3	4	6	7	9	10	0	0	0	-1	-1	-2	-2	-2	-4
20	0	0	1	2	4	6	8	11	11	0	0	1	2	3	5	6	8	10	0	0	0	-1	-1	-1	-2	-2	-4
10	0	0	1	2	4	5	6	9	11	0	0	1	2	3	4	5	6	9	0	0	0	-1	-1	-1	-1	-2	-2
0	0	0	1	2	4	5	6	8	10	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-1	-1	-2
-60	2	2	3	4	5	6	7	9	11	0	0	1	2	3	4	5	6	7	0	0	0	-1	-1	-1	-1	-1	-2

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
70	-5	-2	0	2	5	-3	-2	-1	0	1	3
60	-3	-2	0	2	4	-4	-2	-1	0	1	3
50	-3	-1	0	1	3	-4	-3	-1	0	2	3
40	-2	-1	0	1	2	-4	-3	-1	0	2	3

***V1 not to exceed VR.**

Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	89	87	85	82	80	77	75	71	68
55	89	87	85	82	80	77	75	71	68
50	91	89	85	82	80	77	75	71	68
45	93	91	87	83	80	77	75	71	68
40	96	94	90	85	81	77	75	71	68
35	98	96	92	88	84	79	75	71	68
30	98	98	94	90	87	81	77	72	68
25	98	98	95	92	88	82	78	74	68
20	98	98	95	92	89	84	80	76	70
15	98	98	95	92	89	86	82	77	72
10	98	98	95	92	89	87	84	80	74
5	98	98	95	92	90	87	84	81	76
0	98	98	95	92	90	87	84	81	77
-60	99	99	96	93	90	87	85	82	77

TO2 Stabilizer Trim Setting
20% Thrust Reduction
Flaps 1 and 5

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8 1/2	8 1/2	8 1/4	8	7 1/2	7 1/4	6 3/4	6 1/2	6	5 3/4	5 1/2	5	4 3/4	4 1/4
80	8 1/2	8 1/2	8 1/2	8 1/2	8 1/4	7 3/4	7 1/2	7 1/4	6 3/4	6 1/2	6	5 3/4	5 1/4	5	4 1/2	4 1/4
70	8 1/2	8 1/2	8 1/2	8 1/4	8	7 3/4	7 1/4	7	6 1/2	6 1/4	5 3/4	5 1/2	5	4 3/4	4 1/4	4
60	8 1/2	8 1/2	8 1/4	8	7 3/4	7 1/4	7	6 3/4	6 1/4	6	5 1/2	5 1/4	4 3/4	4 1/2	4	3 3/4
50	8 1/2	8 1/4	7 3/4	7 1/2	7 1/4	6 3/4	6 1/2	6 1/4	5 3/4	5 1/2	5	4 3/4	4 1/4	4	3 1/2	3 1/4
40	7 1/2	7 1/4	7	6 1/2	6 1/4	6	5 1/2	5 1/4	5	4 1/2	4 1/4	4	3 1/2	3 1/4	3	3

Flaps 10, 15, and 25

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8 1/2	8 1/4	7 3/4	7 1/4	6 3/4	6 1/2	6	5 1/2	5 1/4	4 3/4	4 1/4	3 3/4	3 1/2	3
80	8 1/2	8 1/2	8 1/2	8 1/4	7 3/4	7	6 3/4	6 1/4	6	5 1/2	5	4 3/4	4 1/4	3 3/4	3 1/2	3
70	8 1/2	8 1/2	8 1/2	8	7 1/2	7	6 1/2	6	5 3/4	5 1/4	4 3/4	4 1/4	4	3 1/2	3	3
60	8 1/2	8 1/2	8	7 1/2	7	6 1/2	6 1/4	5 3/4	5 1/4	4 3/4	4 1/2	4	3 1/2	3	3	3
50	8	7 1/2	7 1/4	6 3/4	6 1/4	6	5 1/2	5	4 3/4	4 1/4	3 3/4	3 1/2	3	3	3	3
40	6 3/4	6 1/2	6	5 3/4	5 1/4	5	4 1/2	4 1/4	3 3/4	3 1/4	3	3	3	3	3	3

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

20% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6.0	-7.8	-9.5	-11.0	-8.5	-10.2	-11.9	-13.5	-13.3	-15.0	-16.7	-18.3
80	-5.4	-7.1	-8.8	-10.4	-7.3	-9.0	-10.8	-12.3	-11.0	-12.7	-14.4	-16.0
70	-4.5	-6.2	-7.9	-9.5	-5.9	-7.7	-9.4	-10.9	-8.6	-10.3	-12.0	-13.6
60	-3.4	-5.1	-6.8	-8.3	-4.3	-6.0	-7.7	-9.3	-6.0	-7.7	-9.4	-11.0
50	-1.9	-3.6	-5.3	-6.8	-2.4	-4.1	-5.8	-7.3	-3.3	-5.0	-6.7	-8.3
40	-0.1	-1.8	-3.5	-5.1	-0.2	-1.9	-3.6	-5.2	-0.4	-2.1	-3.9	-5.4

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	56.0	33.6			58.0	36.1			61.2	40.7	20.2	
1400	83.0	60.1	37.7	17.6	84.2	62.0	40.1	20.4	85.7	64.9	44.4	25.9
1600	110.7	87.3	64.3	44.0	110.8	88.4	66.1	46.3	110.3	89.5	68.8	50.2
1800		114.7	91.5	70.8		114.8	92.5	72.3		114.0	93.3	74.6
2000				98.1				98.8				99.2

1. **Enter Table 1 with slush/standing water depth and TO2 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8	-3	0	0	-4	0	0	0	0	0	0	0
80	-10	-5	0	0	-6	-1	0	0	0	0	0	0
70	-11	-6	-1	0	-8	-3	0	0	0	0	0	0
60	-13	-8	-3	0	-11	-6	-1	0	-5	0	0	0
50	-16	-11	-6	-1	-14	-9	-4	0	-10	-5	0	0
40	-20	-15	-10	-5	-19	-14	-9	-4	-16	-11	-6	-2

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-7.6	-9.3	-11.1	-12.7	-10.4	-12.1	-13.9	-15.5	-15.6	-17.4	-19.1	-20.7
80	-7.0	-8.8	-10.5	-12.1	-9.2	-10.9	-12.7	-14.2	-13.2	-14.9	-16.6	-18.2
70	-6.2	-8.0	-9.7	-11.3	-7.8	-9.5	-11.3	-12.8	-10.6	-12.3	-14.1	-15.6
60	-5.0	-6.8	-8.5	-10.1	-6.1	-7.8	-9.6	-11.1	-7.8	-9.6	-11.3	-12.9
50	-3.4	-5.2	-6.9	-8.5	-4.0	-5.8	-7.5	-9.1	-4.9	-6.7	-8.4	-10.0
40	-1.5	-3.3	-5.0	-6.6	-1.7	-3.4	-5.2	-6.8	-1.8	-3.6	-5.3	-6.9

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200									33.7			
1300	18.3				33.4				51.0			
1400	48.2				57.6	18.8			68.3	40.5		
1500	71.9	31.9			77.5	43.9			84.2	58.3	29.6	
1600	92.0	57.9	14.2		95.3	65.9	30.7		99.3	74.9	47.9	
1700		80.6	42.3			85.0	53.1	19.9		90.5	65.3	40.1
1800		100.5	68.2	30.1		102.7	74.2	43.2			81.5	58.1
1900			89.2	58.5			92.7	66.0			96.9	74.9
2000			107.4	80.7				85.1				90.4
2100				99.6				102.1				

1. **Enter Table 1 with slush/standing water depth and TO2 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -35 m/+35 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-10	-5	0	0	-5	0	0	0	0	0	0	0
80	-13	-8	-3	0	-8	-3	0	0	0	0	0	0
70	-15	-10	-5	-1	-11	-6	-1	0	0	0	0	0
60	-19	-14	-9	-4	-15	-10	-5	-1	-7	-2	0	0
50	-23	-18	-13	-8	-21	-16	-11	-6	-15	-10	-5	0
40	-27	-22	-17	-13	-26	-21	-16	-12	-23	-18	-13	-9

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff

20% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-3.6	-4.9	-6.2	-7.3	-5.5	-6.8	-8.1	-9.2	-9.3	-10.7	-11.9	-13.1
80	-3.9	-5.2	-6.5	-7.6	-5.4	-6.7	-8.0	-9.2	-8.3	-9.6	-10.9	-12.1
70	-3.8	-5.1	-6.4	-7.6	-4.9	-6.3	-7.5	-8.7	-7.1	-8.3	-9.7	-10.8
60	-3.3	-4.5	-5.9	-7.0	-4.0	-5.3	-6.6	-7.8	-5.4	-6.7	-8.0	-9.2
50	-2.2	-3.4	-4.8	-5.9	-2.6	-3.9	-5.2	-6.4	-3.4	-4.8	-6.0	-7.2
40	-0.5	-1.9	-3.1	-4.3	-0.7	-2.0	-3.3	-4.4	-1.1	-2.4	-3.7	-4.9

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	56.4	35.4			58.9	39.1	19.4		61.5	43.4	25.6	
1400	82.4	61.2	40.1	21.2	83.4	63.4	43.5	25.8	84.0	65.6	47.5	31.5
1600	108.6	87.3	66.0	47.0	108.3	88.1	68.0	50.0	107.1	88.2	69.7	53.4
1800		113.5	92.1	72.9		112.8	92.6	74.5		111.3	92.5	75.7
2000				99.1				99.3				98.7

1. **Enter Table 1 with dry snow depth and TO2 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5	0	0	0	-2	0	0	0	0	0	0	0
80	-7	-2	0	0	-5	0	0	0	0	0	0	0
70	-10	-5	0	0	-7	-2	0	0	-2	0	0	0
60	-13	-8	-3	0	-10	-5	0	0	-5	0	0	0
50	-16	-11	-6	-1	-13	-8	-3	0	-9	-4	0	0
40	-19	-14	-9	-4	-16	-11	-6	-2	-13	-8	-3	0

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4.9	-6.1	-7.3	-8.4	-6.9	-8.2	-9.3	-10.4	-10.7	-11.8	-13.1	-14.2
80	-5.4	-6.6	-7.8	-8.9	-7.0	-8.2	-9.4	-10.5	-9.9	-11.1	-12.3	-13.4
70	-5.5	-6.8	-7.9	-9.0	-6.7	-7.9	-9.1	-10.2	-8.8	-10.0	-11.2	-12.3
60	-5.0	-6.2	-7.4	-8.5	-5.8	-7.0	-8.2	-9.3	-7.2	-8.4	-9.6	-10.7
50	-3.9	-5.1	-6.3	-7.3	-4.3	-5.5	-6.7	-7.8	-5.1	-6.3	-7.5	-8.6
40	-2.1	-3.3	-4.5	-5.6	-2.2	-3.4	-4.6	-5.7	-2.4	-3.7	-4.9	-5.9

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200					28.9				43.6			
1300	32.3				46.7				57.2	35.7		
1400	56.7	18.3			64.5	36.5			70.8	49.6		
1500	76.1	43.5			80.6	54.7	26.0		84.2	63.3	41.9	
1600	93.1	65.2	31.3		95.6	71.6	44.7		97.4	76.8	55.7	36.4
1700		83.9	53.4	21.3		87.3	62.4	37.2		90.1	69.3	50.3
1800		100.8	74.1	44.2		102.3	78.8	55.5			82.8	64.0
1900			91.6	66.7			94.1	72.5			96.0	77.5
2000				84.9				88.1				90.7
2100				101.1				102.8				

1. **Enter Table 1 with dry snow depth and TO2 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6	-1	0	0	-2	0	0	0	0	0	0	0
80	-9	-4	0	0	-6	-1	0	0	0	0	0	0
70	-13	-8	-3	0	-9	-4	0	0	-3	0	0	0
60	-17	-12	-7	-3	-14	-9	-4	0	-7	-2	0	0
50	-22	-17	-12	-7	-18	-13	-8	-4	-12	-7	-2	0
40	-27	-22	-17	-12	-23	-18	-13	-9	-18	-13	-8	-3

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff

20% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4.4	-5.7	-7.1	-8.3	-6.3	-7.6	-9.0	-10.2	-12.1	-13.5	-14.8	-16.1
80	-4.5	-5.9	-7.2	-8.4	-6.0	-7.3	-8.7	-9.9	-10.5	-11.8	-13.2	-14.4
70	-4.2	-5.6	-6.9	-8.2	-5.4	-6.7	-8.1	-9.3	-8.6	-10.0	-11.3	-12.6
60	-3.4	-4.8	-6.1	-7.3	-4.1	-5.5	-6.8	-8.1	-6.3	-7.6	-9.0	-10.2
50	-2.0	-3.4	-4.7	-5.9	-2.4	-3.7	-5.1	-6.3	-3.5	-4.9	-6.3	-7.5
40	0.0	-1.4	-2.8	-4.0	0.0	-1.4	-2.8	-4.0	-0.4	-1.7	-3.1	-4.3

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	55.3	34.2			57.0	36.6			59.8	41.1	22.5	
1400	82.0	60.6	39.5	20.5	82.8	62.1	41.7	23.3	83.4	64.5	45.8	29.0
1600	109.2	87.5	66.0	46.9	108.8	88.0	67.3	48.8	107.2	88.1	69.2	52.3
1800		114.5	92.9	73.4		113.9	93.2	74.6		111.9	92.8	75.8
2000				100.5				100.5				99.5

1. **Enter Table 1 with wet snow depth and TO2 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4	0	0	0	-1	0	0	0	0	0	0	0
80	-8	-3	0	0	-4	0	0	0	0	0	0	0
70	-10	-5	0	0	-7	-2	0	0	0	0	0	0
60	-13	-8	-3	0	-10	-5	0	0	-3	0	0	0
50	-16	-11	-6	-2	-15	-10	-5	0	-9	-4	0	0
40	-21	-16	-11	-7	-20	-15	-10	-5	-17	-12	-7	-3

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5.2	-6.4	-7.6	-8.7	-7.4	-8.6	-9.8	-10.9	-13.6	-14.8	-16.0	-17.1
80	-5.7	-6.9	-8.2	-9.3	-7.4	-8.6	-9.8	-10.9	-12.2	-13.4	-14.6	-15.7
70	-5.8	-7.0	-8.3	-9.3	-6.9	-8.2	-9.4	-10.5	-10.4	-11.6	-12.8	-14.0
60	-5.2	-6.4	-7.6	-8.8	-5.9	-7.1	-8.3	-9.4	-8.1	-9.3	-10.6	-11.7
50	-3.9	-5.1	-6.4	-7.4	-4.2	-5.4	-6.6	-7.8	-5.4	-6.6	-7.8	-8.9
40	-1.9	-3.1	-4.4	-5.4	-1.9	-3.1	-4.4	-5.4	-2.0	-3.3	-4.5	-5.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200									35.2			
1300	22.7				35.4				51.3	25.2		
1400	51.7				58.7	23.0			67.4	42.7		
1500	73.4	37.4			77.3	47.3			82.0	59.2	34.0	
1600	91.5	62.3	24.3		93.5	67.8	35.2		95.8	74.5	50.9	27.8
1700		82.6	49.8			85.4	57.7	26.3		88.8	66.9	44.8
1800		100.4	73.1	40.4		101.5	77.0	50.1		102.5	81.7	61.4
1900			91.6	66.1			93.6	70.7			95.7	76.6
2000				85.3				87.8				90.7
2100				102.0				103.2				

1. **Enter Table 1 with wet snow depth and TO2 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -35 m/+35 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5	0	0	0	-1	0	0	0	0	0	0	0
80	-9	-4	0	0	-5	0	0	0	0	0	0	0
70	-14	-9	-4	0	-9	-4	0	0	0	0	0	0
60	-18	-13	-8	-3	-15	-10	-5	0	-5	0	0	0
50	-23	-18	-13	-9	-21	-16	-11	-6	-14	-9	-4	0
40	-30	-25	-20	-15	-28	-23	-18	-14	-25	-20	-15	-10

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	0.0	-0.7	-1.4	-2.1	-1.2	-2.0	-2.7	-3.4	-8.3	-9.0	-9.8	-10.5
80	-0.4	-1.1	-1.9	-2.6	-2.0	-2.8	-3.5	-4.2	-8.3	-9.1	-9.8	-10.5
70	-0.6	-1.4	-2.1	-2.8	-2.5	-3.2	-4.0	-4.6	-7.9	-8.7	-9.4	-10.1
60	-0.4	-1.1	-1.9	-2.5	-2.4	-3.1	-3.9	-4.5	-6.8	-7.6	-8.3	-9.0
50	0.0	-0.7	-1.5	-2.1	-1.7	-2.4	-3.2	-3.9	-5.1	-5.9	-6.6	-7.3
40	-0.1	-0.8	-1.6	-2.2	-0.5	-1.2	-2.0	-2.6	-2.8	-3.5	-4.3	-4.9

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	91.4	68.6	43.3	19.6	55.6	32.7						
1400		102.3	80.6	59.3	84.7	61.1	38.1	17.5				
1600			113.4	93.8	114.4	90.4	66.7	45.9	33.2			
1800							96.0	74.7	45.8			
2000								104.2	59.0	37.9		
2200									73.8	50.7	30.0	
2400									90.4	64.4	42.6	
2600										79.7	55.7	36.9
2800										96.9	70.0	49.5
3000											86.1	63.2
3200											103.9	78.4
3400												95.4

1. **Enter Table 1 with reported braking action and TO2 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -25 m/+25 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -30 m/+30 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -60 m/+60 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6	-3	-1	0	-9	-7	-4	-2	-26	-23	-21	-18
80	-7	-5	-2	0	-11	-9	-6	-4	-29	-26	-24	-22
70	-8	-5	-3	-1	-13	-10	-8	-6	-32	-29	-27	-25
60	-9	-6	-4	-2	-15	-12	-10	-8	-34	-32	-29	-27
50	-9	-7	-4	-2	-17	-14	-12	-10	-36	-34	-31	-29
40	-10	-7	-5	-3	-19	-17	-14	-12	-38	-35	-33	-31

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-1.6	-2.2	-2.8	-3.4	-3.0	-3.6	-4.3	-4.8	-12.0	-12.6	-13.2	-13.8
80	-2.0	-2.6	-3.2	-3.8	-3.9	-4.5	-5.2	-5.7	-11.9	-12.5	-13.1	-13.7
70	-2.0	-2.6	-3.3	-3.8	-4.4	-5.0	-5.6	-6.2	-11.2	-11.7	-12.4	-12.9
60	-1.6	-2.2	-2.9	-3.4	-4.2	-4.8	-5.4	-5.9	-9.7	-10.3	-10.9	-11.4
50	-0.8	-1.4	-2.0	-2.5	-3.3	-3.9	-4.5	-5.0	-7.3	-7.9	-8.6	-9.1
40	0.0	-0.6	-1.2	-1.8	-1.7	-2.4	-2.9	-3.5	-4.3	-4.9	-5.5	-6.0

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	84.2	51.0										
1300	102.3	78.1	39.5		16.1							
1400		97.1	71.7	33.2	50.6							
1500			91.9	67.2	75.8	33.3						
1600				88.9	95.9	63.2	13.3					
1700				106.8		85.6	47.9					
1800						104.2	74.1	34.7				
1900							94.4	65.1				
2000								87.0				
2100								105.4				
3300									85.6			
3400									101.5			
3600										76.7		
3700										94.1		
3900											51.0	
4000											86.7	
4100											104.2	
4300												84.8
4400												100.3

1. **Enter Table 1 with reported braking action and TO2 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -30 m/+30 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -35 m/+35 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -85 m/+85 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8	-3	0	0	-12	-7	-2	0	-39	-34	-29	-25
80	-9	-4	0	0	-15	-10	-5	0	-45	-40	-35	-31
70	-11	-6	-1	0	-18	-13	-8	-3	-50	-45	-40	-36
60	-12	-7	-2	0	-21	-16	-11	-6	-55	-50	-45	-41
50	-13	-8	-3	0	-24	-19	-14	-10	-60	-55	-50	-45
40	-13	-8	-3	0	-28	-23	-18	-13	-64	-59	-54	-50

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

TO2 Takeoff %N1

20% Thrust Reduction

Based on bleed packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	77.8	78.3	78.8	78.9	78.4	78.0	77.5	77.1	76.7	76.3	75.9	75.5	75.4	75.4	75.4	75.4	75.5	75.5
55	79.2	79.6	80.0	80.1	79.6	79.1	78.7	78.2	77.8	77.3	76.9	76.5	76.1	75.2	74.9	74.9	74.9	74.9
50	80.3	80.8	81.4	81.1	80.7	80.3	79.8	79.4	78.9	78.5	78.1	77.7	77.2	76.3	75.4	74.4	74.3	74.3
45	81.2	81.8	82.3	82.1	81.7	81.2	80.9	80.5	80.1	79.6	79.2	78.8	78.3	77.4	76.5	75.4	74.6	74.2
40	82.1	82.7	83.2	83.1	83.1	82.8	82.2	81.4	81.1	80.7	80.3	79.9	79.4	78.5	77.6	76.6	75.7	75.3
35	82.9	83.5	84.1	84.1	84.0	83.9	83.8	83.5	82.9	82.0	81.3	80.9	80.5	79.6	78.7	77.7	76.9	76.5
30	82.5	83.7	84.9	84.7	84.7	84.7	84.6	84.6	84.5	84.3	82.1	81.8	81.4	80.6	79.8	78.9	78.1	77.7
25	81.8	83.0	84.2	84.5	84.8	84.9	85.0	85.2	85.1	85.1	83.0	82.7	82.3	81.6	80.8	80.0	79.2	78.8
20	81.0	82.2	83.4	83.7	84.0	84.3	84.6	84.9	85.0	85.2	83.9	83.6	83.2	82.5	81.8	81.1	80.3	79.9
15	80.3	81.5	82.7	83.0	83.3	83.5	83.8	84.1	84.4	84.7	84.8	84.5	84.2	83.4	82.7	82.1	81.4	81.1
10	79.6	80.8	82.0	82.2	82.5	82.8	83.1	83.4	83.7	84.0	84.3	84.7	85.0	84.4	83.8	83.2	82.5	82.2
5	78.9	80.0	81.2	81.5	81.8	82.0	82.4	82.6	82.9	83.3	83.6	84.0	84.3	84.3	84.4	84.2	83.6	83.3
0	78.1	79.3	80.5	80.8	81.1	81.3	81.6	81.9	82.2	82.5	82.9	83.2	83.6	83.6	83.7	83.7	83.7	83.8
-5	77.4	78.5	79.7	80.0	80.3	80.5	80.8	81.1	81.4	81.7	82.1	82.5	82.8	82.9	82.9	83.0	83.0	83.0
-10	76.6	77.8	79.0	79.2	79.5	79.8	80.0	80.3	80.6	81.0	81.4	81.7	82.1	82.2	82.2	82.2	82.3	82.3
-15	75.9	77.1	78.2	78.5	78.8	79.0	79.2	79.5	79.9	80.2	80.6	81.0	81.3	81.4	81.5	81.5	81.5	81.5
-20	75.2	76.3	77.5	77.7	78.0	78.2	78.5	78.8	79.1	79.4	79.8	80.2	80.6	80.6	80.7	80.7	80.8	80.8
-25	74.4	75.6	76.7	77.0	77.2	77.5	77.7	78.0	78.3	78.7	79.1	79.5	79.8	79.9	79.9	80.0	80.0	80.0
-30	73.7	74.8	75.9	76.2	76.5	76.7	76.9	77.2	77.5	77.9	78.3	78.7	79.0	79.1	79.2	79.2	79.2	79.3
-35	72.9	74.0	75.1	75.4	75.7	75.9	76.2	76.4	76.7	77.1	77.5	77.9	78.2	78.3	78.4	78.4	78.5	78.5
-40	72.1	73.2	74.3	74.6	74.9	75.1	75.4	75.7	76.0	76.3	76.7	77.1	77.4	77.5	77.5	77.6	77.7	77.7
-45	71.4	72.5	73.6	73.8	74.1	74.3	74.6	74.9	75.2	75.5	75.9	76.2	76.6	76.6	76.7	76.8	76.9	76.9
-50	70.6	71.7	72.7	73.0	73.3	73.5	73.8	74.0	74.4	74.7	75.0	75.4	75.7	75.8	75.9	76.0	76.1	76.1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.2	1.3	1.6	1.7	1.7
ENGINE ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0

TO2 Assumed Temperature Reduced Thrust

Maximum Assumed Temperature (Table 1 of 3)

Based on 25% Takeoff Thrust Reduction

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	67	69	70	70	69	68	66	65	64	62	61	60	59	59	57	59	58	57
55	67	69	70	70	69	68	66	65	64	62	61	60	58	56	54	55	53	52
50	67	69	70	70	69	68	66	65	64	62	61	60	58	56	53	50	49	49
45	67	69	70	70	69	68	66	65	64	62	61	60	58	56	53	50	47	46
40	67	68	68	68	67	67	66	65	64	62	61	60	58	56	53	50	47	46
35	64	63	63	63	63	61	60	59	60	61	61	60	58	56	53	50	48	47
30	63	61	59	59	58	57	56	54	53	52	55	57	57	56	53	51	48	47
25	63	61	59	58	56	54	53	51	49	48	50	52	52	52	51	51	48	47
20	63	61	59	58	56	54	52	49	47	46	46	48	48	47	47	46	46	46
15	63	61	59	58	56	54	52	49	47	45	43	43	43	42	42	41	41	41
10	63	61	59	58	56	54	52	49	47	45	43	41	38	37	37	36	36	36
5	63	61	59	58	56	54	52	49	47	45	43	41	38	36	33	32	31	31
0	63	61	59	59	57	54	52	49	47	45	43	41	39	36	33	31	28	27
-5 & BELOW	63	61	59	59	57	54	52	49	47	45	43	41	39	36	34	31	28	27

Takeoff %N1 (Table 2 of 3)

Based on engine bleed for packs on and engine anti-ice off

ASSUMED TEMP (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
75	77.0	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.0	76.6	76.5	76.4
70	76.5	76.5	76.6	76.7	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.6	76.6	76.6	76.6	76.1	75.8
65	76.8	77.2	77.7	77.8	77.3	76.9	76.4	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0	76.0
60	77.8	78.3	78.8	78.9	78.4	78.0	77.5	77.1	76.7	76.3	75.9	75.5	75.4	75.4	75.4	75.4	75.5	75.5
55	79.2	79.6	80.0	80.1	79.6	79.1	78.7	78.2	77.8	77.3	76.9	76.5	76.1	75.2	74.9	74.9	74.9	74.9
50	80.3	80.8	81.4	81.1	80.7	80.3	79.8	79.4	78.9	78.5	78.1	77.7	77.2	76.3	75.4	74.4	74.3	74.3
45	81.2	81.8	82.3	82.1	81.7	81.2	80.9	80.5	80.1	79.6	79.2	78.8	78.3	77.4	76.5	75.4	74.6	74.2
40	82.1	82.7	83.2	83.1	83.1	82.8	82.2	81.4	81.1	80.7	80.3	79.9	79.4	78.5	77.6	76.6	75.7	75.3
35	82.9	83.5	84.1	84.1	84.0	83.9	83.8	83.5	82.9	82.0	81.3	80.9	80.5	79.6	78.7	77.7	76.9	76.5
30	82.5	83.7	84.9	84.7	84.7	84.7	84.6	84.6	84.5	84.3	82.1	81.8	81.4	80.6	79.8	78.9	78.1	77.7
25	81.8	83.0	84.2	84.5	84.8	84.9	85.0	85.2	85.1	85.1	83.0	82.7	82.3	81.6	80.8	80.0	79.2	78.8
20	81.0	82.2	83.4	83.7	84.0	84.3	84.6	84.9	85.0	85.2	83.9	83.6	83.2	82.5	81.8	81.1	80.3	79.9
15	80.3	81.5	82.7	83.0	83.3	83.5	83.8	84.1	84.4	84.7	84.8	84.5	84.2	83.4	82.7	82.1	81.4	81.1
10	79.6	80.8	82.0	82.2	82.5	82.8	83.1	83.4	83.7	84.0	84.3	84.7	85.0	84.4	83.8	83.2	82.5	82.2
5	78.9	80.0	81.2	81.5	81.8	82.0	82.4	82.6	82.9	83.3	83.6	84.0	84.3	84.3	84.4	84.2	83.6	83.3
0	78.1	79.3	80.5	80.8	81.1	81.3	81.6	81.9	82.2	82.5	82.9	83.2	83.6	83.6	83.7	83.7	83.7	83.8
-5	77.4	78.5	79.7	80.0	80.3	80.5	80.8	81.1	81.4	81.7	82.1	82.5	82.8	82.9	82.9	83.0	83.0	83.0
-20	75.2	76.3	77.5	77.7	78.0	78.2	78.5	78.8	79.1	79.4	79.8	80.2	80.6	80.6	80.7	80.7	80.8	80.8
-40	72.1	73.2	74.3	74.6	74.9	75.1	75.4	75.7	76.0	76.3	76.7	77.1	77.4	77.5	77.5	77.6	77.7	77.7
MINIMUM ASSUMED TEMP (°C)	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	1

TO2 Assumed Temperature Reduced Thrust

%N1 Adjustment for Temperature Difference (Table 3 of 3)

ASSUMED TEMP MINUS OAT (°C)	OUTSIDE AIR TEMPERATURE (°C)													
	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
115	7.9													
110	7.9													
105	7.9													
100	7.1													
95	5.4	8.2												
90	4.0	8.2												
85	2.6	8.2												
80	1.3	7.4												
75	0.1	5.6	8.5											
70	0.0	4.2	8.4	8.4										
65	0.0	2.7	7.9	7.9	7.8									
60	0.0	1.4	7.4	7.3	7.3	7.2								
55	0.0	0.0	5.9	6.8	6.8	6.7	6.5							
50	0.0	0.0	4.3	5.9	6.2	6.2	6.0	5.8						
45	0.0	0.0	2.9	4.4	5.7	5.6	5.5	5.3	5.0					
40	0.0	0.0	1.4	2.9	4.5	5.1	4.9	4.8	4.6	3.3				
35		0.0	0.0	1.5	3.0	4.5	4.4	4.2	4.1	3.3	1.4			
30		0.0	0.0	0.1	1.5	3.0	3.8	3.7	3.6	3.3	1.4	0.0		
25		0.0	0.0	0.0	0.1	1.5	3.1	3.1	3.0	2.9	1.4	0.0	0.0	
20		0.0	0.0	0.0	0.0	0.1	1.6	2.5	2.4	2.4	1.4	0.0	0.0	0.0
15			0.0	0.0	0.0	0.0	0.2	1.6	1.8	1.8	1.4	0.0	0.0	0.0
10			0.0	0.0	0.0	0.0	0.0	0.2	1.2	1.2	1.2	0.0	0.0	0.0
5			0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.6	0.0	0.0	0.0
0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1. **Determine Maximum Assumed Temperature allowed from Table 1.**
2. **Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).**
3. **Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.**
4. **Subtract %N1 adjustment from Maximum %N1 in Table 2.**

Max Climb %N1

Based on engine bleed for packs on and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KIAS OR MACH)											
	0	5	10	15	20	25	30	33	35	37	39	41
	280	280	280	280	280	280	280	0.78	0.78	0.78	0.78	0.78
60	80.8	81.3	84.0	86.0	88.3	90.3	93.1	94.6	95.7	96.0	95.4	94.7
55	81.6	81.6	83.3	85.3	87.7	89.6	92.4	93.9	94.9	95.2	94.6	94.0
50	82.6	82.5	82.8	84.7	87.0	88.9	91.7	93.1	94.2	94.5	93.9	93.3
45	83.6	83.4	83.6	84.0	86.3	88.2	90.9	92.4	93.5	93.8	93.2	92.6
40	84.5	84.5	84.5	84.3	85.6	87.5	90.2	91.7	92.7	93.0	92.4	91.8
35	85.2	85.5	85.5	85.2	85.2	86.8	89.5	91.0	92.0	92.3	91.7	91.1
30	84.5	86.5	86.5	86.2	85.7	86.1	88.8	90.2	91.2	91.5	91.0	90.4
25	83.8	86.6	87.5	87.1	86.6	87.7	88.0	89.5	90.5	90.8	90.2	89.6
20	83.1	85.8	88.4	88.0	87.5	88.7	89.2	89.1	89.7	90.0	89.4	88.9
15	82.3	85.1	87.8	89.0	88.5	89.8	90.2	90.5	89.6	89.2	88.7	88.1
10	81.6	84.3	87.1	89.4	89.5	90.9	91.1	91.3	91.0	90.0	89.5	88.9
5	80.8	83.6	86.3	88.7	90.6	91.9	91.9	92.0	91.8	91.1	90.7	90.1
0	80.1	82.8	85.5	87.9	89.9	92.9	92.6	92.6	92.3	91.8	91.3	90.6
-5	79.4	82.0	84.7	87.1	89.2	92.7	93.4	93.4	93.1	92.4	91.9	91.2
-10	78.6	81.2	84.0	86.4	88.3	91.9	93.6	94.3	94.0	93.2	92.6	91.8
-15	77.9	80.5	83.2	85.6	87.5	91.1	92.8	94.1	94.8	94.1	93.5	92.7
-20	77.1	79.7	82.4	84.8	86.7	90.2	91.9	93.2	94.4	94.4	93.9	93.1
-25	76.3	78.9	81.5	84.0	85.8	89.4	91.0	92.3	93.4	93.5	93.0	92.2
-30	75.6	78.1	80.7	83.2	85.0	88.5	90.1	91.4	92.5	92.6	92.1	91.3
-35	74.8	77.3	79.9	82.4	84.1	87.6	89.3	90.5	91.6	91.7	91.2	90.4
-40	74.0	76.5	79.0	81.5	83.3	86.7	88.4	89.6	90.7	90.7	90.2	89.5

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)											
	0	5	10	15	20	25	30	33	35	37	39	41
ENGINE ANTI-ICE	0.0	0.0	-0.6	-0.7	-0.8	-0.9	-1.2	-1.5	-1.8	-2.0	-2.1	-2.1
ENGINE & WING ANTI-ICE	0.0	0.0	-1.5	-1.7	-2.0	-2.1	-2.6	-3.2	-4.0	-4.2	-4.2	-4.2

Go-Around %N1

Based on engine bleed for packs on and anti-ice off

REPORTED OAT (°C)	TAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
59	60	85.8	86.3	86.8	86.9	86.4	86.0	85.5	85.0	84.6	84.2	83.8	83.3	82.9	81.9	81.0	79.9	79.0	78.6
54	55	87.2	87.6	88.0	88.0	87.6	87.1	86.7	86.2	85.8	85.3	84.9	84.5	84.0	83.1	82.2	81.1	80.2	79.8
49	50	88.1	88.7	89.3	89.0	88.6	88.2	87.8	87.3	86.9	86.5	86.1	85.6	85.1	84.2	83.3	82.3	81.4	81.0
44	45	89.1	89.7	90.2	90.1	89.8	89.1	88.8	88.4	88.0	87.5	87.1	86.7	86.2	85.3	84.4	83.4	82.5	82.1
39	40	90.0	90.6	91.2	91.1	91.0	90.9	90.4	89.6	89.0	88.6	88.2	87.8	87.3	86.4	85.5	84.5	83.6	83.2
34	35	90.8	91.5	92.1	92.1	92.0	91.9	91.8	91.6	91.2	90.3	89.1	88.8	88.3	87.5	86.6	85.6	84.8	84.4
29	30	90.1	91.4	92.7	92.7	92.7	92.7	92.7	92.6	92.6	92.5	90.0	89.7	89.3	88.5	87.7	86.8	85.9	85.5
24	25	89.3	90.6	91.9	92.2	92.5	92.8	92.9	93.1	93.2	93.1	91.0	90.6	90.2	89.5	88.7	87.9	87.1	86.7
19	20	88.5	89.8	91.0	91.4	91.7	92.0	92.3	92.6	92.8	93.0	91.9	91.6	91.2	90.5	89.7	89.0	88.2	87.8
14	15	87.7	89.0	90.2	90.5	90.8	91.2	91.5	91.8	92.1	92.4	92.8	92.6	92.3	91.5	90.8	90.1	89.4	89.0
9	10	86.9	88.2	89.4	89.7	90.0	90.3	90.7	91.0	91.3	91.6	92.0	92.4	92.8	92.5	91.9	91.3	90.6	90.2
4	5	86.1	87.4	88.6	88.9	89.2	89.5	89.9	90.2	90.5	90.8	91.2	91.6	92.0	92.0	92.0	92.1	91.7	91.3
-1	0	85.3	86.5	87.8	88.1	88.5	88.7	89.0	89.3	89.7	90.0	90.4	90.8	91.2	91.2	91.3	91.3	91.3	91.3
-6	-5	84.5	85.7	87.0	87.3	87.6	87.9	88.2	88.5	88.8	89.2	89.6	90.0	90.4	90.4	90.5	90.5	90.5	90.5
-11	-10	83.7	84.9	86.2	86.5	86.8	87.0	87.3	87.6	88.0	88.3	88.8	89.2	89.6	89.6	89.7	89.7	89.7	89.7
-16	-15	82.9	84.1	85.3	85.6	85.9	86.2	86.4	86.8	87.1	87.5	87.9	88.3	88.7	88.8	88.8	88.9	88.9	88.9
-21	-20	82.1	83.3	84.5	84.8	85.1	85.4	85.6	85.9	86.3	86.7	87.1	87.5	87.9	88.0	88.0	88.0	88.1	88.1
-26	-25	81.3	82.5	83.7	84.0	84.3	84.5	84.8	85.1	85.4	85.8	86.2	86.7	87.0	87.1	87.2	87.2	87.2	87.3
-31	-30	80.4	81.6	82.8	83.1	83.4	83.7	83.9	84.2	84.6	85.0	85.4	85.8	86.2	86.3	86.3	86.4	86.4	86.4
-36	-35	79.6	80.8	82.0	82.3	82.6	82.8	83.1	83.4	83.7	84.1	84.5	84.9	85.3	85.4	85.4	85.5	85.6	85.6
-41	-40	78.8	80.0	81.1	81.4	81.7	82.0	82.2	82.5	82.9	83.2	83.6	84.0	84.4	84.5	84.6	84.6	84.7	84.7
-46	-45	77.9	79.1	80.3	80.6	80.9	81.1	81.4	81.7	82.0	82.4	82.7	83.1	83.5	83.6	83.6	83.7	83.8	83.8
-51	-50	77.1	78.2	79.4	79.7	80.0	80.2	80.5	80.8	81.1	81.5	81.8	82.2	82.6	82.7	82.7	82.8	82.9	82.9

%N1 Adjustment forEngine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.2	1.4	1.6	1.7	1.8
A/C HIGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINE & WING ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	-1.4	-1.5	-1.4	-1.4	-1.5	-1.5
ENGINE & WING ANTI-ICE*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.8	-2.2	-2.3	-2.3	-2.3	-2.4	-2.5

***Single Bleed Source**

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

CLIMB (280/.76)
Flaps Up, Set Max Climb Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG) 40	50	60	70	80	90
40000	**PITCH ATT**	**4.0**	**4.0**	**4.5**			
	V/S (FT/MIN)	1700	1100	600			
30000	**PITCH ATT**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**
	V/S (FT/MIN)	2500	1900	1500	1100	800	600
20000	**PITCH ATT**	**6.5**	**6.0**	**5.5**	**5.5**	**5.5**	**6.0**
	V/S (FT/MIN)	3700	2900	2300	1800	1500	1200
10000	**PITCH ATT**	**10.0**	**8.5**	**8.0**	**7.5**	**7.5**	**7.5**
	V/S (FT/MIN)	5100	4000	3200	2700	2200	1900
SEA LEVEL	**PITCH ATT**	**14.0**	**11.5**	**10.5**	**9.5**	**9.0**	**9.0**
	V/S (FT/MIN)	6300	4900	4000	3300	2800	2400

CRUISE (.76/280)
Flaps Up, Set Thrust for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG) 40	50	60	70	80	90
40000	**PITCH ATT**	**2.0**	**2.5**	**3.5**			
	%N1	**78.4**	**80.9**	**84.5**			
35000	**PITCH ATT**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	
	%N1	**76.8**	**78.2**	**80.0**	**82.5**	**85.7**	
30000	**PITCH ATT**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**
	%N1	**76.2**	**77.1**	**78.3**	**79.8**	**81.6**	**84.2**
25000	**PITCH ATT**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**4.0**
	%N1	**72.2**	**73.0**	**74.3**	**75.7**	**77.6**	**79.8**
20000	**PITCH ATT**	**1.0**	**1.5**	**2.0**	**3.0**	**3.5**	**4.0**
	%N1	**68.1**	**69.0**	**70.1**	**71.5**	**73.2**	**75.4**
15000	**PITCH ATT**	**1.0**	**1.5**	**2.5**	**3.0**	**3.5**	**4.0**
	%N1	**64.3**	**65.0**	**66.1**	**67.3**	**68.9**	**70.9**

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

DESCENT (.76/280)

Flaps Up, Set Idle Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		40	50	60	70	80	90
40000	**PITCH ATT**	**-1.0**	**0.0**	**0.5**	**1.5**	**1.5**	**1.0**
	V/S (FT/MIN)	-2400	-2200	-2200	-2300	-2800	-3600
30000	**PITCH ATT**	**-3.0**	**-2.0**	**-1.0**	**0.0**	**0.5**	**1.0**
	V/S (FT/MIN)	-3000	-2500	-2200	-2000	-1900	-1900
20000	**PITCH ATT**	**-3.5**	**-2.0**	**-1.0**	**0.0**	**0.5**	**1.5**
	V/S (FT/MIN)	-2900	-2400	-2100	-1900	-1800	-1700
10000	**PITCH ATT**	**-3.5**	**-2.0**	**-1.0**	**0.0**	**0.5**	**1.5**
	V/S (FT/MIN)	-2700	-2200	-1900	-1800	-1600	-1600
SEA LEVEL	**PITCH ATT**	**-4.0**	**-2.5**	**-1.5**	**-0.5**	**0.5**	**1.0**
	V/S (FT/MIN)	-2400	-2000	-1800	-1600	-1500	-1400

HOLDING (VREF40 + 70)

Flaps Up, Set Thrust for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		40	50	60	70	80	90
15000	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.0**	**5.5**	**5.0**
	%N1	**49.9**	**54.5**	**59.1**	**63.2**	**66.8**	**70.1**
	KIAS	178	191	206	224	240	254
10000	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**5.5**	**5.5**
	%N1	**46.7**	**51.0**	**55.1**	**59.0**	**62.6**	**65.7**
	KIAS	178	191	206	222	238	253
5000	**PITCH ATT**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**	**5.5**
	%N1	**43.7**	**47.8**	**51.7**	**55.3**	**58.8**	**61.9**
	KIAS	178	191	204	222	237	251

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)

Set Thrust for Level Flight

Airport Altitude = -2000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.5**
(GEAR UP)	**%N1**	**41.9**	**45.9**	**49.7**	**53.1**	**56.4**	**59.7**
(VREF40+70)	KIAS	176	189	202	212	223	236
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**44.1**	**48.2**	**52.1**	**55.6**	**59.1**	**62.5**
(VREF40+50)	KIAS	156	169	182	192	203	216
FLAPS 5	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.5**	**6.0**
(GEAR UP)	**%N1**	**43.5**	**48.1**	**52.4**	**56.0**	**59.7**	**63.1**
(VREF40+30)	KIAS	136	149	162	172	183	196
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**5.0**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**44.7**	**49.4**	**53.6**	**57.4**	**61.1**	**64.6**
(VREF40+30)	KIAS	136	149	162	172	183	196
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**	**5.5**
(GEAR UP)	**%N1**	**44.9**	**49.9**	**54.2**	**58.2**	**62.0**	**65.5**
(VREF40+20)	KIAS	126	139	152	162	173	186
FLAPS 25	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**45.7**	**50.8**	**55.3**	**59.5**	**63.3**	**66.7**
(VREF40+10)	KIAS	116	129	142	152	163	176
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**	**5.5**
(GEAR DOWN)	**%N1**	**49.1**	**54.2**	**58.9**	**63.2**	**67.2**	**70.9**
(VREF40+20)	KIAS	126	139	152	162	173	186

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)
Set Thrust for Level Flight
Airport Altitude = -1000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP (GEAR UP) (VREF40+70)	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.5**
	%N1	**42.4**	**46.5**	**50.4**	**53.8**	**57.1**	**60.4**
	KIAS	176	189	202	212	223	236
FLAPS 1 (GEAR UP) (VREF40+50)	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
	%N1	**44.6**	**48.8**	**52.8**	**56.3**	**59.9**	**63.3**
	KIAS	156	169	182	192	203	216
FLAPS 5 (GEAR UP) (VREF40+30)	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.5**	**6.0**
	%N1	**44.1**	**48.8**	**53.0**	**56.7**	**60.4**	**63.9**
	KIAS	136	149	162	172	183	196
FLAPS 10 (GEAR UP) (VREF40+30)	**PITCH ATT**	**4.0**	**4.5**	**5.0**	**5.0**	**5.0**	**5.0**
	%N1	**45.3**	**50.0**	**54.3**	**58.2**	**61.9**	**65.5**
	KIAS	136	149	162	172	183	196
FLAPS 15 (GEAR UP) (VREF40+20)	**PITCH ATT**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**	**5.5**
	%N1	**45.6**	**50.6**	**54.9**	**59.0**	**62.8**	**66.4**
	KIAS	126	139	152	162	173	186
FLAPS 25 (GEAR UP) (VREF40+10)	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.5**	**6.0**	**6.0**
	%N1	**46.3**	**51.5**	**56.0**	**60.3**	**64.2**	**67.5**
	KIAS	116	129	142	152	163	176
FLAPS 15 (GEAR DOWN) (VREF40+20)	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**
	%N1	**49.7**	**54.9**	**59.7**	**64.0**	**68.0**	**71.8**
	KIAS	126	139	152	162	173	186

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)

Set Thrust for Level Flight

Airport Altitude = SEA LEVEL

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.5**
(GEAR UP)	**%N1**	**43.0**	**47.1**	**51.0**	**54.5**	**57.9**	**61.2**
(VREF40+70)	KIAS	176	190	202	212	224	236
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**45.1**	**49.5**	**53.5**	**57.0**	**60.7**	**64.1**
(VREF40+50)	KIAS	156	170	182	192	204	216
FLAPS 5	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**44.7**	**49.4**	**53.6**	**57.4**	**61.2**	**64.7**
(VREF40+30)	KIAS	136	150	162	172	184	196
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**5.0**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**45.9**	**50.7**	**54.9**	**58.9**	**62.7**	**66.3**
(VREF40+30)	KIAS	136	150	162	172	184	196
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**	**5.5**
(GEAR UP)	**%N1**	**46.2**	**51.2**	**55.5**	**59.7**	**63.6**	**67.2**
(VREF40+20)	KIAS	126	140	152	162	174	186
FLAPS 25	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**46.9**	**52.1**	**56.6**	**61.0**	**65.0**	**68.4**
(VREF40+10)	KIAS	116	130	142	152	164	176
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR DOWN)	**%N1**	**50.3**	**55.5**	**60.5**	**64.9**	**68.9**	**72.7**
(VREF40+20)	KIAS	126	140	152	162	174	186

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)

Set Thrust for Level Flight

Airport Altitude = 1000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.5**
(GEAR UP)	**%N1**	**43.6**	**47.7**	**51.6**	**55.2**	**58.7**	**61.9**
(VREF40+70)	KIAS	177	190	202	212	224	236
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**45.7**	**50.1**	**54.1**	**57.8**	**61.5**	**65.0**
(VREF40+50)	KIAS	157	170	182	192	204	216
FLAPS 5	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**45.3**	**50.1**	**54.3**	**58.2**	**62.0**	**65.6**
(VREF40+30)	KIAS	137	150	162	172	184	196
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**5.0**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**46.5**	**51.4**	**55.6**	**59.7**	**63.6**	**67.2**
(VREF40+30)	KIAS	137	150	162	172	184	196
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**	**5.5**
(GEAR UP)	**%N1**	**46.7**	**51.8**	**56.2**	**60.5**	**64.5**	**68.0**
(VREF40+20)	KIAS	127	140	152	162	174	186
FLAPS 25	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**47.5**	**52.7**	**57.4**	**61.9**	**65.9**	**69.3**
(VREF40+10)	KIAS	117	130	142	152	164	176
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR DOWN)	**%N1**	**50.9**	**56.2**	**61.3**	**65.8**	**69.8**	**73.8**
(VREF40+20)	KIAS	127	140	152	162	174	186

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)

Set Thrust for Level Flight

Airport Altitude = 2000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.5**
(GEAR UP)	**%N1**	**44.2**	**48.4**	**52.3**	**55.9**	**59.4**	**62.7**
(VREF40+70)	KIAS	177	190	202	213	224	236
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**46.3**	**50.8**	**54.9**	**58.6**	**62.3**	**65.8**
(VREF40+50)	KIAS	157	170	182	193	204	216
FLAPS 5	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**45.9**	**50.8**	**55.0**	**59.1**	**62.9**	**66.5**
(VREF40+30)	KIAS	137	150	162	173	184	196
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**5.0**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**47.1**	**52.0**	**56.4**	**60.6**	**64.5**	**68.1**
(VREF40+30)	KIAS	137	150	162	173	184	196
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**
(GEAR UP)	**%N1**	**47.3**	**52.4**	**57.0**	**61.4**	**65.5**	**68.9**
(VREF40+20)	KIAS	127	140	152	163	174	186
FLAPS 25	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**5.5**
(GEAR UP)	**%N1**	**48.1**	**53.4**	**58.1**	**62.7**	**66.7**	**70.2**
(VREF40+10)	KIAS	117	130	142	153	164	176
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR DOWN)	**%N1**	**51.6**	**57.0**	**62.2**	**66.7**	**70.8**	**74.8**
(VREF40+20)	KIAS	127	140	152	163	174	186

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)
Set Thrust for Level Flight
Airport Altitude = 3000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP (GEAR UP) (VREF40+70)	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.5**
	%N1	**44.7**	**49.1**	**53.0**	**56.6**	**60.2**	**63.5**
	KIAS	177	190	203	213	224	237
FLAPS 1 (GEAR UP) (VREF40+50)	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
	%N1	**46.9**	**51.6**	**55.6**	**59.4**	**63.2**	**66.7**
	KIAS	157	170	183	193	204	217
FLAPS 5 (GEAR UP) (VREF40+30)	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**	**6.0**
	%N1	**46.4**	**51.4**	**55.8**	**59.9**	**63.8**	**67.4**
	KIAS	137	150	163	173	184	197
FLAPS 10 (GEAR UP) (VREF40+30)	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**5.0**
	%N1	**47.6**	**52.6**	**57.1**	**61.5**	**65.4**	**69.0**
	KIAS	137	150	163	173	184	197
FLAPS 15 (GEAR UP) (VREF40+20)	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**
	%N1	**47.9**	**53.1**	**57.8**	**62.3**	**66.3**	**69.9**
	KIAS	127	140	153	163	174	187
FLAPS 25 (GEAR UP) (VREF40+10)	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**5.5**
	%N1	**48.8**	**54.0**	**58.9**	**63.7**	**67.6**	**71.2**
	KIAS	117	130	143	153	164	177
FLAPS 15 (GEAR DOWN) (VREF40+20)	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
	%N1	**52.2**	**57.8**	**63.1**	**67.6**	**71.8**	**75.8**
	KIAS	127	140	153	163	174	187

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)
Set Thrust for Level Flight
Airport Altitude = 4000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**45.3**	**49.7**	**53.7**	**57.4**	**61.0**	**64.3**
(VREF40+70)	KIAS	177	190	203	213	224	237
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**47.6**	**52.3**	**56.4**	**60.3**	**64.1**	**67.6**
(VREF40+50)	KIAS	157	170	183	193	204	217
FLAPS 5	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**47.0**	**52.1**	**56.5**	**60.8**	**64.7**	**68.3**
(VREF40+30)	KIAS	137	150	163	173	184	197
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**48.3**	**53.3**	**58.0**	**62.4**	**66.3**	**70.0**
(VREF40+30)	KIAS	137	150	163	173	184	197
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**
(GEAR UP)	**%N1**	**48.5**	**53.7**	**58.6**	**63.2**	**67.2**	**70.9**
(VREF40+20)	KIAS	127	140	153	163	174	187
FLAPS 25	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**5.5**
(GEAR UP)	**%N1**	**49.4**	**54.7**	**59.7**	**64.6**	**68.5**	**72.2**
(VREF40+10)	KIAS	117	130	143	153	164	177
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR DOWN)	**%N1**	**52.9**	**58.6**	**64.1**	**68.5**	**72.8**	**76.9**
(VREF40+20)	KIAS	127	140	153	163	174	187

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)
Set Thrust for Level Flight
Airport Altitude = 5000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP (GEAR UP) (VREF40+70)	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
	%N1	**45.9**	**50.4**	**54.4**	**58.2**	**61.8**	**65.1**
	KIAS	177	191	203	213	225	237
FLAPS 1 (GEAR UP) (VREF40+50)	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
	%N1	**48.2**	**53.0**	**57.2**	**61.2**	**65.0**	**68.5**
	KIAS	157	171	183	193	205	217
FLAPS 5 (GEAR UP) (VREF40+30)	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**	**6.0**
	%N1	**47.7**	**52.7**	**57.4**	**61.7**	**65.7**	**69.3**
	KIAS	137	151	163	173	185	197
FLAPS 10 (GEAR UP) (VREF40+30)	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**5.0**
	%N1	**49.0**	**54.0**	**58.9**	**63.3**	**67.2**	**71.0**
	KIAS	137	151	163	173	185	197
FLAPS 15 (GEAR UP) (VREF40+20)	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
	%N1	**49.2**	**54.4**	**59.5**	**64.2**	**68.1**	**71.9**
	KIAS	127	141	153	163	175	187
FLAPS 25 (GEAR UP) (VREF40+10)	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**5.5**
	%N1	**50.0**	**55.4**	**60.6**	**65.5**	**69.5**	**73.2**
	KIAS	117	131	143	153	165	177
FLAPS 15 (GEAR DOWN) (VREF40+20)	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
	%N1	**53.5**	**59.5**	**65.0**	**69.5**	**73.8**	**78.0**
	KIAS	127	141	153	163	175	187

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)
Set Thrust for Level Flight
Airport Altitude = 6000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**46.5**	**51.0**	**55.1**	**59.0**	**62.7**	**66.0**
(VREF40+70)	KIAS	177	191	203	213	225	238
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**48.9**	**53.7**	**58.0**	**62.0**	**65.9**	**69.4**
(VREF40+50)	KIAS	157	171	183	193	205	218
FLAPS 5	**PITCH ATT**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**48.3**	**53.5**	**58.3**	**62.6**	**66.6**	**70.2**
(VREF40+30)	KIAS	137	151	163	173	185	198
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**49.7**	**54.8**	**59.8**	**64.2**	**68.2**	**72.0**
(VREF40+30)	KIAS	137	151	163	173	185	198
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR UP)	**%N1**	**49.8**	**55.2**	**60.4**	**65.1**	**69.1**	**72.9**
(VREF40+20)	KIAS	127	141	153	163	175	188
FLAPS 25	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**5.5**
(GEAR UP)	**%N1**	**50.6**	**56.2**	**61.6**	**66.4**	**70.5**	**74.2**
(VREF40+10)	KIAS	117	131	143	153	165	178
FLAPS 15	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR DOWN)	**%N1**	**54.3**	**60.4**	**65.9**	**70.5**	**74.9**	**79.1**
(VREF40+20)	KIAS	127	141	153	163	175	188

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)
Set Thrust for Level Flight
Airport Altitude = 7000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**47.1**	**51.7**	**55.9**	**59.8**	**63.5**	**66.9**
(VREF40+70)	KIAS	177	191	203	213	225	238
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**49.7**	**54.4**	**58.9**	**63.0**	**66.8**	**70.4**
(VREF40+50)	KIAS	157	171	183	193	205	218
FLAPS 5	**PITCH ATT**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**49.1**	**54.3**	**59.1**	**63.5**	**67.5**	**71.2**
(VREF40+30)	KIAS	137	151	163	173	185	198
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**50.4**	**55.7**	**60.7**	**65.2**	**69.2**	**72.9**
(VREF40+30)	KIAS	137	151	163	173	185	198
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR UP)	**%N1**	**50.5**	**56.0**	**61.4**	**66.0**	**70.1**	**73.9**
(VREF40+20)	KIAS	127	141	153	163	175	188
FLAPS 25	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**5.5**
(GEAR UP)	**%N1**	**51.3**	**57.0**	**62.6**	**67.3**	**71.5**	**75.3**
(VREF40+10)	KIAS	117	131	143	153	165	178
FLAPS 15	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR DOWN)	**%N1**	**55.0**	**61.4**	**66.9**	**71.5**	**75.9**	**80.1**
(VREF40+20)	KIAS	127	141	153	163	175	188

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)

Set Thrust for Level Flight

Airport Altitude = 8000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**47.8**	**52.4**	**56.7**	**60.7**	**64.4**	**67.8**
(VREF40+70)	KIAS	177	191	204	214	226	238
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**50.4**	**55.2**	**59.8**	**63.9**	**67.7**	**71.3**
(VREF40+50)	KIAS	157	171	184	194	206	218
FLAPS 5	**PITCH ATT**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**49.8**	**55.1**	**60.0**	**64.5**	**68.5**	**72.2**
(VREF40+30)	KIAS	137	151	164	174	186	198
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**51.0**	**56.5**	**61.6**	**66.1**	**70.2**	**74.0**
(VREF40+30)	KIAS	137	151	164	174	186	198
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR UP)	**%N1**	**51.2**	**56.9**	**62.3**	**66.9**	**71.1**	**74.9**
(VREF40+20)	KIAS	127	141	154	164	176	188
FLAPS 25	**PITCH ATT**	**6.0**	**6.0**	**6.0**	**6.0**	**6.0**	**5.5**
(GEAR UP)	**%N1**	**52.0**	**57.9**	**63.5**	**68.3**	**72.5**	**76.3**
(VREF40+10)	KIAS	117	131	144	154	166	178
FLAPS 15	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR DOWN)	**%N1**	**55.8**	**62.4**	**67.9**	**72.6**	**77.0**	**81.1**
(VREF40+20)	KIAS	127	141	154	164	176	188

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)
Set Thrust for Level Flight
Airport Altitude = 9000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**48.5**	**53.2**	**57.6**	**61.6**	**65.3**	**68.7**
(VREF40+70)	KIAS	178	191	204	214	226	239
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**51.2**	**56.0**	**60.7**	**64.8**	**68.7**	**72.3**
(VREF40+50)	KIAS	158	171	184	194	206	219
FLAPS 5	**PITCH ATT**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**50.5**	**56.0**	**61.0**	**65.4**	**69.5**	**73.2**
(VREF40+30)	KIAS	138	151	164	174	186	199
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**51.8**	**57.5**	**62.6**	**67.0**	**71.2**	**75.0**
(VREF40+30)	KIAS	138	151	164	174	186	199
FLAPS 15	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR UP)	**%N1**	**51.9**	**57.8**	**63.3**	**67.9**	**72.1**	**76.0**
(VREF40+20)	KIAS	128	141	154	164	176	189
FLAPS 25	**PITCH ATT**	**5.5**	**6.0**	**6.0**	**6.0**	**6.0**	**5.5**
(GEAR UP)	**%N1**	**52.7**	**58.8**	**64.5**	**69.3**	**73.5**	**77.4**
(VREF40+10)	KIAS	118	131	144	154	166	179
FLAPS 15	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR DOWN)	**%N1**	**56.7**	**63.4**	**68.9**	**73.6**	**78.1**	**82.1**
(VREF40+20)	KIAS	128	141	154	164	176	189

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)
Set Thrust for Level Flight
Airport Altitude = 10000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**49.2**	**53.9**	**58.4**	**62.4**	**66.2**	**69.6**
(VREF40+70)	KIAS	178	192	204	214	226	239
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**51.9**	**56.9**	**61.6**	**65.7**	**69.7**	**73.3**
(VREF40+50)	KIAS	158	172	184	194	206	219
FLAPS 5	**PITCH ATT**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**51.2**	**56.8**	**61.9**	**66.4**	**70.5**	**74.3**
(VREF40+30)	KIAS	138	152	164	174	186	199
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**52.5**	**58.4**	**63.5**	**68.0**	**72.2**	**76.0**
(VREF40+30)	KIAS	138	152	164	174	186	199
FLAPS 15	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR UP)	**%N1**	**52.7**	**58.8**	**64.3**	**68.9**	**73.2**	**77.0**
(VREF40+20)	KIAS	128	142	154	164	176	189
FLAPS 25	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**	**5.5**
(GEAR UP)	**%N1**	**53.5**	**59.8**	**65.4**	**70.3**	**74.6**	**78.4**
(VREF40+10)	KIAS	118	132	144	154	166	179
FLAPS 15	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.0**	**5.0**
(GEAR DOWN)	**%N1**	**57.7**	**64.4**	**69.9**	**74.7**	**79.2**	**83.1**
(VREF40+20)	KIAS	128	142	154	164	176	189

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)

Set Thrust for Level Flight

Airport Altitude = 11000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP (GEAR UP) (VREF40+70)	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
	%N1	**49.9**	**54.7**	**59.2**	**63.3**	**67.1**	**70.6**
	KIAS	178	192	204	214	227	240
FLAPS 1 (GEAR UP) (VREF40+50)	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**5.5**
	%N1	**52.6**	**57.8**	**62.6**	**66.6**	**70.6**	**74.3**
	KIAS	158	172	184	194	207	220
FLAPS 5 (GEAR UP) (VREF40+30)	**PITCH ATT**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**
	%N1	**52.0**	**57.7**	**62.9**	**67.3**	**71.5**	**75.3**
	KIAS	138	152	164	174	187	200
FLAPS 10 (GEAR UP) (VREF40+30)	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**5.0**
	%N1	**53.4**	**59.3**	**64.5**	**69.0**	**73.2**	**77.1**
	KIAS	138	152	164	174	187	200
FLAPS 15 (GEAR UP) (VREF40+20)	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
	%N1	**53.5**	**59.8**	**65.2**	**69.9**	**74.2**	**78.1**
	KIAS	128	142	154	164	177	190
FLAPS 25 (GEAR UP) (VREF40+10)	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**	**5.5**
	%N1	**54.4**	**60.9**	**66.4**	**71.3**	**75.6**	**79.4**
	KIAS	118	132	144	154	167	180
FLAPS 15 (GEAR DOWN) (VREF40+20)	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.0**	**5.0**
	%N1	**58.8**	**65.4**	**70.9**	**75.7**	**80.2**	**84.2**
	KIAS	128	142	154	164	177	190

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)

Set Thrust for Level Flight

Airport Altitude = 12000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**50.6**	**55.5**	**60.1**	**64.3**	**68.0**	**71.6**
(VREF40+70)	KIAS	178	192	204	214	227	240
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**6.0**	**5.5**
(GEAR UP)	**%N1**	**53.4**	**58.7**	**63.5**	**67.6**	**71.6**	**75.3**
(VREF40+50)	KIAS	158	172	184	194	207	220
FLAPS 5	**PITCH ATT**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**52.8**	**58.6**	**63.9**	**68.3**	**72.5**	**76.3**
(VREF40+30)	KIAS	138	152	164	174	187	200
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**54.3**	**60.3**	**65.4**	**70.0**	**74.2**	**78.1**
(VREF40+30)	KIAS	138	152	164	174	187	200
FLAPS 15	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.5**	**5.0**
(GEAR UP)	**%N1**	**54.5**	**60.8**	**66.2**	**70.9**	**75.2**	**79.1**
(VREF40+20)	KIAS	128	142	154	164	177	190
FLAPS 25	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**	**5.5**
(GEAR UP)	**%N1**	**55.3**	**62.0**	**67.4**	**72.4**	**76.7**	**80.4**
(VREF40+10)	KIAS	118	132	144	154	167	180
FLAPS 15	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.0**	**5.0**
(GEAR DOWN)	**%N1**	**59.9**	**66.4**	**72.0**	**76.8**	**81.2**	**85.3**
(VREF40+20)	KIAS	128	142	154	164	177	190

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)
Set Thrust for Level Flight
Airport Altitude = 13000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP (GEAR UP) (VREF40+70)	**PITCH ATT** **%N1** KIAS	**4.5** **51.3** 178	**5.0** **56.4** 192	**5.5** **61.0** 204	**6.0** **65.2** 215	**6.0** **69.0** 227	**6.0** **72.5** 241
FLAPS 1 (GEAR UP) (VREF40+50)	**PITCH ATT** **%N1** KIAS	**4.5** **54.2** 158	**5.0** **59.6** 172	**5.5** **64.4** 184	**5.5** **68.6** 195	**5.5** **72.6** 207	**5.5** **76.4** 221
FLAPS 5 (GEAR UP) (VREF40+30)	**PITCH ATT** **%N1** KIAS	**5.0** **53.7** 138	**5.5** **59.6** 152	**5.5** **64.8** 164	**6.0** **69.3** 175	**6.0** **73.5** 187	**6.0** **77.4** 201
FLAPS 10 (GEAR UP) (VREF40+30)	**PITCH ATT** **%N1** KIAS	**4.0** **55.2** 138	**4.5** **61.3** 152	**4.5** **66.4** 164	**5.0** **71.0** 175	**5.0** **75.3** 187	**5.0** **79.1** 201
FLAPS 15 (GEAR UP) (VREF40+20)	**PITCH ATT** **%N1** KIAS	**4.5** **55.4** 128	**5.0** **61.8** 142	**5.0** **67.2** 154	**5.5** **72.0** 165	**5.0** **76.3** 177	**5.0** **80.1** 191
FLAPS 25 (GEAR UP) (VREF40+10)	**PITCH ATT** **%N1** KIAS	**5.5** **56.3** 118	**5.5** **63.0** 132	**5.5** **68.4** 144	**6.0** **73.4** 155	**5.5** **77.7** 167	**5.5** **81.4** 181
FLAPS 15 (GEAR DOWN) (VREF40+20)	**PITCH ATT** **%N1** KIAS	**4.5** **61.0** 128	**5.0** **67.4** 142	**5.0** **73.0** 154	**5.5** **77.9** 165	**5.0** **82.3** 177	**5.0** **86.4** 191

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)

Set Thrust for Level Flight

Airport Altitude = 14000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**52.1**	**57.2**	**61.9**	**66.1**	**69.9**	**73.5**
(VREF40+70)	KIAS	179	192	205	215	228	241
FLAPS 1	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**5.5**	**5.5**
(GEAR UP)	**%N1**	**55.1**	**60.6**	**65.4**	**69.6**	**73.7**	**77.4**
(VREF40+50)	KIAS	159	172	185	195	208	221
FLAPS 5	**PITCH ATT**	**5.0**	**5.5**	**5.5**	**6.0**	**6.0**	**6.0**
(GEAR UP)	**%N1**	**54.5**	**60.6**	**65.8**	**70.3**	**74.6**	**78.4**
(VREF40+30)	KIAS	139	152	165	175	188	201
FLAPS 10	**PITCH ATT**	**4.0**	**4.5**	**4.5**	**5.0**	**5.0**	**4.5**
(GEAR UP)	**%N1**	**56.1**	**62.2**	**67.4**	**72.0**	**76.4**	**80.1**
(VREF40+30)	KIAS	139	152	165	175	188	201
FLAPS 15	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.0**	**5.0**
(GEAR UP)	**%N1**	**56.4**	**62.9**	**68.2**	**73.0**	**77.4**	**81.1**
(VREF40+20)	KIAS	129	142	155	165	178	191
FLAPS 25	**PITCH ATT**	**5.5**	**5.5**	**5.5**	**6.0**	**5.5**	**5.5**
(GEAR UP)	**%N1**	**57.3**	**63.9**	**69.4**	**74.5**	**78.8**	**82.5**
(VREF40+10)	KIAS	119	132	145	155	168	181
FLAPS 15	**PITCH ATT**	**4.5**	**5.0**	**5.0**	**5.5**	**5.0**	**5.0**
(GEAR DOWN)	**%N1**	**62.1**	**68.4**	**74.1**	**79.0**	**83.3**	**87.5**
(VREF40+20)	KIAS	129	142	155	165	178	191

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

FINAL APPROACH (1500 FT)
Gear Down, Set Thrust for 3° Glideslope
Airport Altitude = -2000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG) 40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**35.5**	**38.9**	**42.0**	**44.8**	**47.4**	**49.9**
	KIAS	128	142	155	166	176	186
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**40.0**	**44.2**	**48.1**	**51.6**	**54.7**	**57.6**
	KIAS	122	135	148	158	169	178
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.5**	**0.0**	**-0.5**
	%N1	**44.4**	**49.2**	**53.5**	**57.2**	**61.0**	**64.9**
	KIAS	116	129	141	151	162	175

Flap placard speed exceeded in shaded area.

Airport Altitude = -1000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG) 40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**35.8**	**39.2**	**42.5**	**45.3**	**48.0**	**50.5**
	KIAS	128	142	155	166	176	186
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**40.5**	**44.8**	**48.7**	**52.2**	**55.3**	**58.2**
	KIAS	122	135	148	159	169	178
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.5**	**0.0**	**-0.5**
	%N1	**45.0**	**49.8**	**54.2**	**57.9**	**61.8**	**65.7**
	KIAS	116	129	141	151	163	175

Flap placard speed exceeded in shaded area.

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

FINAL APPROACH (1500 FT)

Gear Down, Set Thrust for 3° Glideslope

Airport Altitude = SEA LEVEL

FLAP/GEAR POSITION		WEIGHT (1000 KG) 40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**36.1**	**39.6**	**43.0**	**45.8**	**48.6**	**51.1**
	KIAS	128	142	155	166	176	187
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**41.0**	**45.4**	**49.4**	**52.8**	**55.9**	**58.9**
	KIAS	122	135	148	159	169	178
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**45.6**	**50.5**	**54.8**	**58.6**	**62.5**	**66.5**
	KIAS	116	129	141	151	163	175

Flap placard speed exceeded in shaded area.

Airport Altitude = 1000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG) 40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**36.4**	**40.1**	**43.5**	**46.4**	**49.2**	**51.8**
	KIAS	128	142	155	166	176	187
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**41.6**	**46.0**	**50.0**	**53.4**	**56.6**	**59.6**
	KIAS	122	135	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**46.2**	**51.1**	**55.5**	**59.3**	**63.3**	**67.2**
	KIAS	116	129	141	151	163	175

Flap placard speed exceeded in shaded area.

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

FINAL APPROACH (1500 FT)

Gear Down, Set Thrust for 3° Glideslope

Airport Altitude = 2000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**36.7**	**40.5**	**44.0**	**46.9**	**49.7**	**52.4**
	KIAS	128	142	155	166	177	187
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**42.1**	**46.6**	**50.7**	**54.0**	**57.2**	**60.3**
	KIAS	122	135	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**46.8**	**51.7**	**56.1**	**60.1**	**64.1**	**68.0**
	KIAS	116	129	141	152	163	176

Flap placard speed exceeded in shaded area.

Airport Altitude = 3000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**37.1**	**41.1**	**44.5**	**47.5**	**50.3**	**53.0**
	KIAS	128	142	155	166	177	187
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**42.7**	**47.2**	**51.3**	**54.6**	**57.9**	**61.0**
	KIAS	122	136	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**47.4**	**52.3**	**56.8**	**60.9**	**65.0**	**68.9**
	KIAS	116	129	142	152	163	176

Flap placard speed exceeded in shaded area.

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

FINAL APPROACH (1500 FT)
Gear Down, Set Thrust for 3° Glideslope

Airport Altitude = 4000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG) 40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**37.5**	**41.6**	**45.0**	**48.1**	**51.0**	**53.6**
	KIAS	128	142	155	166	177	187
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**43.2**	**47.8**	**51.9**	**55.3**	**58.7**	**61.8**
	KIAS	122	136	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**48.0**	**53.0**	**57.6**	**61.7**	**65.8**	**69.8**
	KIAS	116	129	142	152	163	176

Flap placard speed exceeded in shaded area.

Airport Altitude = 5000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG) 40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**37.9**	**42.1**	**45.6**	**48.7**	**51.6**	**54.3**
	KIAS	128	142	155	166	177	187
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**43.7**	**48.3**	**52.5**	**56.0**	**59.4**	**62.7**
	KIAS	122	136	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**48.7**	**53.7**	**58.3**	**62.5**	**66.7**	**70.7**
	KIAS	116	130	142	152	164	176

Flap placard speed exceeded in shaded area.

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

FINAL APPROACH (1500 FT)
Gear Down, Set Thrust for 3° Glideslope

Airport Altitude = 6000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**38.3**	**42.5**	**46.1**	**49.3**	**52.3**	**54.9**
	KIAS	128	142	155	166	177	187
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**44.3**	**49.0**	**53.1**	**56.7**	**60.2**	**63.5**
	KIAS	122	136	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**49.3**	**54.3**	**59.2**	**63.5**	**67.6**	**71.7**
	KIAS	117	130	142	152	164	176

Flap placard speed exceeded in shaded area.

Airport Altitude = 7000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**38.8**	**43.0**	**46.7**	**49.9**	**52.9**	**55.6**
	KIAS	128	142	155	166	177	187
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**44.9**	**49.6**	**53.7**	**57.4**	**61.1**	**64.4**
	KIAS	122	136	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**49.8**	**55.0**	**60.1**	**64.4**	**68.5**	**72.7**
	KIAS	117	130	142	153	164	176

Flap placard speed exceeded in shaded area.

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

FINAL APPROACH (1500 FT)

Gear Down, Set Thrust for 3° Glideslope

Airport Altitude = 8000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**39.3**	**43.5**	**47.4**	**50.6**	**53.6**	**56.3**
	KIAS	128	142	155	166	177	187
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**45.4**	**50.2**	**54.4**	**58.3**	**62.0**	**65.3**
	KIAS	122	136	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**50.5**	**55.8**	**61.0**	**65.3**	**69.5**	**73.7**
	KIAS	117	130	143	153	164	177

Flap placard speed exceeded in shaded area.

Airport Altitude = 9000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**39.8**	**44.1**	**48.0**	**51.3**	**54.2**	**57.0**
	KIAS	128	142	155	166	177	187
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**46.0**	**50.8**	**55.1**	**59.1**	**62.8**	**66.1**
	KIAS	122	136	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**51.1**	**56.6**	**62.0**	**66.2**	**70.5**	**74.8**
	KIAS	117	130	143	153	164	177

Flap placard speed exceeded in shaded area.

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

FINAL APPROACH (1500 FT)

Gear Down, Set Thrust for 3° Glideslope

Airport Altitude = 10000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**40.4**	**44.7**	**48.6**	**51.9**	**54.9**	**57.8**
	KIAS	128	142	155	166	177	188
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**46.6**	**51.5**	**55.9**	**60.0**	**63.7**	**67.0**
	KIAS	122	136	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**-0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**51.9**	**57.5**	**63.0**	**67.2**	**71.5**	**75.8**
	KIAS	117	131	143	153	165	177

Flap placard speed exceeded in shaded area.

Airport Altitude = 11000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**40.9**	**45.3**	**49.3**	**52.6**	**55.6**	**58.6**
	KIAS	128	142	155	166	177	188
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**47.2**	**52.1**	**56.8**	**60.9**	**64.6**	**67.9**
	KIAS	122	136	148	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**-0.5**	**-0.5**	**-0.5**	**0.0**	**0.0**	**-0.5**
	%N1	**52.6**	**58.4**	**63.9**	**68.1**	**72.5**	**76.9**
	KIAS	117	131	143	153	165	178

Flap placard speed exceeded in shaded area.

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

FINAL APPROACH (1500 FT)
Gear Down, Set Thrust for 3° Glideslope

Airport Altitude = 12000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**41.5**	**46.0**	**50.0**	**53.2**	**56.4**	**59.4**
	KIAS	128	142	155	166	177	188
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**47.9**	**52.9**	**57.6**	**61.8**	**65.5**	**68.8**
	KIAS	122	136	149	159	169	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**-0.5**	**-0.5**	**-0.5**	**0.0**	**0.0**	**-0.5**
	%N1	**53.3**	**59.4**	**64.9**	**69.1**	**73.6**	**78.0**
	KIAS	117	131	143	153	165	178

Flap placard speed exceeded in shaded area.

Airport Altitude = 13000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**42.0**	**46.6**	**50.7**	**53.9**	**57.1**	**60.2**
	KIAS	128	142	155	166	177	188
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**48.6**	**53.6**	**58.5**	**62.6**	**66.4**	**69.8**
	KIAS	122	136	149	159	170	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**-0.5**	**-0.5**	**-0.5**	**0.0**	**0.0**	**-0.5**
	%N1	**54.1**	**60.4**	**65.8**	**70.1**	**74.6**	**79.1**
	KIAS	117	131	144	154	166	178

Flap placard speed exceeded in shaded area.

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

FINAL APPROACH (1500 FT)

Gear Down, Set Thrust for 3° Glideslope

Airport Altitude = 14000 FT

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**1.5**	**2.0**	**2.0**	**2.0**	**2.0**
	%N1	**42.7**	**47.3**	**51.3**	**54.6**	**57.9**	**61.1**
	KIAS	128	142	155	166	178	189
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.0**
	%N1	**49.3**	**54.4**	**59.4**	**63.6**	**67.3**	**70.7**
	KIAS	122	136	149	159	170	179
FLAPS 40 (VREF40+10)	**PITCH ATT**	**-0.5**	**-0.5**	**-0.5**	**0.0**	**-0.5**	**-0.5**
	%N1	**55.0**	**61.5**	**66.8**	**71.2**	**75.7**	**80.1**
	KIAS	118	131	144	154	166	179

Flap placard speed exceeded in shaded area.

GO-AROUND

Flaps 15, Gear Up, Set Go-Around Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		40	50	60	70	80	90
14000	**PITCH ATT**	**17.5**	**13.5**	**11.5**	**10.0**	**8.5**	**7.5**
	V/S (FT/MIN)	3500	2700	2100	1600	1300	900
	KIAS	128	141	154	164	176	189
10000	**PITCH ATT**	**20.5**	**16.5**	**13.5**	**11.5**	**10.0**	**9.0**
	V/S (FT/MIN)	4200	3300	2600	2100	1700	1400
	KIAS	127	141	153	163	175	187
5000	**PITCH ATT**	**24.0**	**19.0**	**16.0**	**13.5**	**12.0**	**10.5**
	V/S (FT/MIN)	4700	3800	3100	2500	2100	1800
	KIAS	126	140	152	162	174	186
SEA LEVEL	**PITCH ATT**	**28.5**	**22.5**	**18.5**	**16.0**	**14.0**	**12.0**
	V/S (FT/MIN)	5300	4300	3600	3000	2600	2200
	KIAS	126	139	151	161	173	185
-2000	**PITCH ATT**	**29.0**	**23.0**	**19.0**	**16.5**	**14.0**	**12.5**
	V/S (FT/MIN)	5200	4300	3600	3000	2500	2200
	KIAS	126	139	151	161	172	185

Performance Inflight — Chapter PI
All Engine — Section 11

Long Range Cruise Maximum Operating Altitude
Max Cruise Thrust
ISA + 10°C and Below

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
85	33500	-12	35000*	35000*	35000*	34200	32600
80	34800	-15	36200*	36200*	36200*	35500	33900
75	36200	-18	37400*	37400*	37400*	36800	35200
70	37600	-18	38700*	38700*	38700*	38200	36700
65	39100	-18	40000*	40000*	40000*	39800	38200
60	40800	-18	41000	41000	41000	41000	39900
55	41000	-18	41000	41000	41000	41000	41000
50	41000	-18	41000	41000	41000	41000	41000
45	41000	-18	41000	41000	41000	41000	41000
40	41000	-18	41000	41000	41000	41000	41000

ISA + 15°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
85	33500	-6	34000*	34000*	34000*	34000*	32600
80	34800	-9	35500*	35500*	35500*	35500	33900
75	36200	-12	36700*	36700*	36700*	36700*	35200
70	37600	-12	37900*	37900*	37900*	37900*	36700
65	39100	-12	39200*	39200*	39200*	39200*	38200
60	40800	-12	40400*	40400*	40400*	40400*	39900
55	41000	-12	41000	41000	41000	41000	41000
50	41000	-12	41000	41000	41000	41000	41000
45	41000	-12	41000	41000	41000	41000	41000
40	41000	-12	41000	41000	41000	41000	41000

ISA + 20°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
85	33500	-1	32400*	32400*	32400*	32400*	32400*
80	34800	-4	34300*	34300*	34300*	34300*	33900
75	36200	-7	35800*	35800*	35800*	35800*	35200
70	37600	-7	37000*	37000*	37000*	37000*	36700
65	39100	-7	38200*	38200*	38200*	38200*	38200
60	40800	-7	39500*	39500*	39500*	39500*	39500*
55	41000	-7	40900*	40900*	40900*	40900*	40900*
50	41000	-7	41000	41000	41000	41000	41000
45	41000	-7	41000	41000	41000	41000	41000
40	41000	-7	41000	41000	41000	41000	41000

***Denotes altitude thrust limited in level flight, 100 fpm residual rate of climb.**

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)								
		25	27	29	31	33	35	37	39	41
85	%N1	80.4	81.8	83.4	84.7	86.2	88.1			
	MACH	.737	.762	.787	.796	.797	.789			
	KIAS	309	307	305	296	283	268			
	FF/ENG	1312	1305	1303	1289	1276	1278			
80	%N1	79.1	80.6	82.0	83.5	84.9	86.4			
	MACH	.719	.744	.770	.792	.797	.795			
	KIAS	301	300	298	294	283	270			
	FF/ENG	1239	1234	1228	1225	1210	1200			
75	%N1	77.7	79.2	80.6	82.1	83.5	85.0	87.0		
	MACH	.700	.726	.751	.778	.794	.797	.793		
	KIAS	292	292	290	289	282	271	257		
	FF/ENG	1165	1161	1155	1153	1146	1134	1134		
70	%N1	76.0	77.7	79.1	80.6	82.1	83.4	85.3	88.2	
	MACH	.679	.706	.732	.758	.784	.796	.797	.789	
	KIAS	283	283	282	280	278	270	259	244	
	FF/ENG	1089	1088	1083	1077	1079	1068	1063	1078	
65	%N1	74.2	75.9	77.5	79.0	80.4	82.0	83.7	86.0	
	MACH	.656	.683	.710	.737	.763	.788	.796	.796	
	KIAS	273	273	273	272	270	268	258	247	
	FF/ENG	1013	1012	1010	1006	1002	1004	997	1001	
60	%N1	72.3	74.0	75.7	77.3	78.8	80.2	82.1	84.2	86.6
	MACH	.633	.658	.686	.714	.740	.767	.791	.797	.795
	KIAS	263	263	263	262	261	260	256	247	235
	FF/ENG	939	935	935	933	930	928	935	933	936
55	%N1	70.3	71.9	73.6	75.3	76.9	78.4	80.2	82.5	84.6
	MACH	.612	.633	.659	.687	.715	.742	.770	.792	.797
	KIAS	254	252	252	252	252	250	249	245	236
	FF/ENG	872	861	858	859	858	861	864	870	868
50	%N1	68.2	69.8	71.3	73.1	74.8	76.4	78.2	80.4	82.7
	MACH	.589	.610	.632	.658	.686	.715	.742	.770	.792
	KIAS	244	242	241	240	241	240	239	238	234
	FF/ENG	804	796	783	785	783	794	797	808	803
45	%N1	65.5	67.4	69.0	70.6	72.3	74.0	76.0	78.2	80.4
	MACH	.558	.584	.607	.628	.654	.683	.712	.740	.767
	KIAS	230	231	231	229	229	229	228	227	226
	FF/ENG	727	734	722	717	715	725	731	739	747
40	%N1	62.6	64.3	66.2	68.0	69.6	71.2	73.4	75.8	77.9
	MACH	.527	.550	.576	.600	.622	.647	.676	.706	.734
	KIAS	217	217	218	218	217	216	216	216	215
	FF/ENG	669	661	665	657	659	654	663	670	679

Shaded area approximates optimum altitude.

Long Range Cruise Enroute Fuel and Time - Low Altitudes

Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
295	270	248	230	214	200	190	181	173	166	159
444	406	373	345	321	300	286	272	260	249	239
594	543	498	461	429	400	381	363	347	332	319
744	680	623	576	536	500	476	454	434	415	398
894	817	749	692	643	600	571	544	520	498	478
1044	953	874	807	750	700	666	635	607	581	558
1195	1091	999	923	858	800	761	726	693	664	638
1346	1228	1125	1039	965	900	857	817	780	747	718
1498	1366	1251	1155	1073	1000	952	908	867	830	797
1650	1504	1377	1270	1180	1100	1047	998	954	913	876
1802	1643	1503	1386	1288	1200	1142	1089	1040	995	955
1955	1781	1629	1503	1395	1300	1238	1180	1127	1078	1035
2108	1920	1756	1619	1503	1400	1333	1270	1213	1161	1114
2261	2059	1882	1735	1611	1500	1427	1360	1299	1243	1193
2415	2199	2009	1852	1718	1600	1522	1451	1385	1325	1272
2569	2338	2136	1968	1826	1700	1617	1541	1472	1408	1351
2724	2478	2263	2085	1934	1800	1713	1632	1558	1491	1430
2879	2619	2391	2202	2042	1900	1807	1722	1644	1573	1509
3035	2760	2519	2319	2150	2000	1902	1812	1730	1655	1588

Table 2 of 3: Reference Fuel And Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		20		24		28	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	1.2	0:42	1.1	0:40	0.9	0:38	0.8	0:37	0.7	0:35
300	1.9	1:02	1.7	0:59	1.5	0:55	1.3	0:53	1.2	0:50
400	2.5	1:22	2.3	1:18	2.0	1:12	1.8	1:09	1.6	1:06
500	3.2	1:42	2.9	1:37	2.6	1:29	2.3	1:25	2.1	1:21
600	3.8	2:02	3.5	1:56	3.1	1:46	2.8	1:41	2.6	1:36
700	4.4	2:22	4.1	2:15	3.7	2:04	3.3	1:57	3.0	1:51
800	5.1	2:42	4.7	2:34	4.2	2:21	3.8	2:13	3.5	2:07
900	5.7	3:02	5.3	2:53	4.7	2:38	4.3	2:30	3.9	2:22
1000	6.3	3:23	5.9	3:12	5.3	2:56	4.8	2:46	4.4	2:38
1100	7.0	3:43	6.5	3:32	5.8	3:14	5.2	3:03	4.8	2:53
1200	7.6	4:04	7.1	3:51	6.3	3:31	5.7	3:19	5.3	3:09
1300	8.2	4:25	7.7	4:11	6.9	3:49	6.2	3:36	5.7	3:25
1400	8.9	4:45	8.2	4:31	7.4	4:07	6.7	3:52	6.2	3:40
1500	9.5	5:06	8.8	4:50	7.9	4:25	7.2	4:09	6.6	3:56
1600	10.1	5:27	9.4	5:10	8.5	4:43	7.6	4:26	7.1	4:12
1700	10.7	5:49	10.0	5:30	9.0	5:01	8.1	4:43	7.5	4:28
1800	11.3	6:10	10.6	5:50	9.5	5:20	8.6	5:00	8.0	4:44
1900	11.9	6:31	11.1	6:11	10.0	5:38	9.1	5:17	8.4	5:00
2000	12.6	6:53	11.7	6:31	10.5	5:57	9.5	5:34	8.8	5:16

Long Range Cruise Enroute Fuel and Time - Low Altitudes
Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	40	50	60	70	80
1	-0.1	0.0	0.0	0.0	0.1
2	-0.2	-0.1	0.0	0.1	0.3
3	-0.3	-0.2	0.0	0.2	0.4
4	-0.4	-0.2	0.0	0.3	0.6
5	-0.5	-0.3	0.0	0.4	0.8
6	-0.7	-0.3	0.0	0.5	0.9
7	-0.8	-0.4	0.0	0.6	1.1
8	-0.9	-0.4	0.0	0.7	1.3
9	-1.0	-0.5	0.0	0.7	1.5
10	-1.1	-0.6	0.0	0.8	1.6
11	-1.3	-0.6	0.0	0.9	1.8
12	-1.4	-0.7	0.0	1.0	2.0
13	-1.5	-0.7	0.0	1.1	2.2

Long Range Cruise Enroute Fuel and Time - High Altitudes

Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
538	504	473	446	422	400	382	366	351	337	325
804	754	708	668	633	600	574	549	527	507	489
1071	1005	944	891	843	800	765	733	704	677	653
1339	1256	1180	1113	1054	1000	957	917	880	846	816
1607	1507	1416	1336	1265	1200	1149	1101	1057	1016	979
1876	1759	1652	1559	1476	1400	1340	1284	1233	1186	1142
2146	2011	1889	1782	1687	1600	1531	1468	1409	1355	1305
2417	2264	2126	2005	1898	1800	1723	1651	1584	1524	1468
2688	2518	2364	2229	2109	2000	1914	1834	1760	1692	1631
2960	2772	2602	2453	2321	2200	2105	2017	1935	1861	1794
3233	3027	2840	2677	2532	2400	2296	2200	2111	2030	1956
3507	3282	3079	2901	2744	2600	2487	2383	2287	2198	2118
3780	3537	3318	3126	2955	2800	2679	2566	2462	2366	2279
4055	3793	3557	3350	3167	3000	2870	2749	2637	2535	2441
4331	4050	3796	3575	3379	3200	3061	2931	2812	2702	2603
4607	4307	4036	3800	3590	3400	3252	3114	2987	2870	2764
4883	4564	4277	4025	3802	3600	3442	3296	3161	3038	2925
5161	4823	4517	4251	4015	3800	3633	3479	3336	3205	3086
5439	5081	4758	4477	4227	4000	3824	3661	3510	3372	3247
5718	5340	4999	4702	4439	4200	4015	3843	3684	3539	3408
5998	5600	5241	4928	4651	4400	4205	4025	3859	3706	3568
6279	5860	5483	5154	4864	4600	4396	4207	4033	3873	3728
6561	6121	5725	5381	5076	4800	4587	4389	4207	4040	3888
6844	6383	5968	5608	5289	5000	4778	4571	4381	4206	4048
7128	6646	6212	5835	5502	5200	4968	4753	4554	4372	4207
7414	6909	6456	6062	5715	5400	5158	4934	4727	4538	4367
7701	7174	6701	6290	5928	5600	5348	5115	4900	4704	4525
7989	7440	6946	6518	6141	5800	5539	5296	5073	4869	4684
8278	7706	7192	6747	6355	6000	5729	5477	5246	5034	4842

Long Range Cruise Enroute Fuel and Time - High Altitudes

Table 2 of 3: Reference Fuel And Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	29		31		33		35		37	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
400	1.6	1:05	1.6	1:03	1.5	1:02	1.4	1:01	1.4	1:00
600	2.5	1:35	2.4	1:32	2.3	1:30	2.3	1:28	2.2	1:27
800	3.4	2:05	3.3	2:02	3.2	1:59	3.1	1:56	3.0	1:53
1000	4.3	2:35	4.2	2:31	4.0	2:27	3.9	2:24	3.8	2:20
1200	5.2	3:06	5.0	3:01	4.9	2:56	4.7	2:52	4.6	2:47
1400	6.1	3:37	5.9	3:30	5.7	3:25	5.5	3:20	5.4	3:14
1600	6.9	4:08	6.7	4:00	6.5	3:54	6.3	3:48	6.2	3:41
1800	7.8	4:39	7.6	4:31	7.3	4:23	7.1	4:16	6.9	4:09
2000	8.7	5:11	8.4	5:01	8.1	4:52	7.9	4:44	7.7	4:36
2200	9.5	5:43	9.2	5:32	8.9	5:22	8.7	5:13	8.5	5:04
2400	10.4	6:15	10.0	6:03	9.7	5:52	9.5	5:42	9.2	5:32
2600	11.2	6:47	10.9	6:34	10.5	6:22	10.3	6:11	10.0	6:00
2800	12.0	7:19	11.7	7:05	11.3	6:52	11.0	6:40	10.7	6:28
3000	12.9	7:52	12.5	7:37	12.1	7:22	11.8	7:09	11.5	6:56
3200	13.7	8:25	13.3	8:09	12.8	7:53	12.6	7:39	12.2	7:25
3400	14.5	8:58	14.0	8:41	13.6	8:24	13.3	8:09	13.0	7:54
3600	15.3	9:31	14.8	9:13	14.4	8:55	14.1	8:39	13.7	8:23
3800	16.1	10:05	15.6	9:46	15.1	9:27	14.8	9:09	14.4	8:52
4000	16.9	10:39	16.4	10:18	15.9	9:58	15.5	9:40	15.1	9:21
4200	17.7	11:13	17.2	10:51	16.6	10:30	16.3	10:10	15.9	9:50
4400	18.5	11:47	17.9	11:25	17.4	11:02	17.0	10:41	16.6	10:20
4600	19.3	12:22	18.7	11:58	18.1	11:34	17.7	11:12	17.3	10:50
4800	20.0	12:57	19.4	12:32	18.9	12:07	18.4	11:44	18.0	11:20
5000	20.8	13:32	20.2	13:06	19.6	12:40	19.2	12:15	18.7	11:50
5200	21.6	14:08	20.9	13:40	20.3	13:13	19.9	12:48	19.4	12:21
5400	22.4	14:44	21.7	14:14	21.1	13:46	20.6	13:20	20.1	12:51
5600	23.1	15:20	22.4	14:49	21.8	14:20	21.3	13:52	20.8	13:22
5800	23.9	15:57	23.1	15:24	22.5	14:54	22.0	14:25	21.4	13:54
6000	24.7	16:34	23.9	16:00	23.2	15:28	22.7	14:58	22.1	14:25

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	40	50	60	70	80
2	-0.2	-0.1	0.0	0.2	0.5
4	-0.5	-0.3	0.0	0.4	1.0
6	-0.8	-0.5	0.0	0.6	1.5
8	-1.1	-0.6	0.0	0.8	2.0
10	-1.4	-0.7	0.0	1.0	2.4
12	-1.7	-0.9	0.0	1.2	2.8
14	-2.0	-1.0	0.0	1.4	3.2
16	-2.3	-1.2	0.0	1.5	3.6
18	-2.6	-1.3	0.0	1.7	3.9
20	-2.9	-1.4	0.0	1.8	4.2
22	-3.3	-1.6	0.0	2.0	4.5
24	-3.6	-1.7	0.0	2.1	4.7
26	-4.0	-1.9	0.0	2.2	4.9

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 KG)									
	85	80	75	70	65	60	55	50	45	40
41					13	1	0	3	14	30
39			25	8	0	0	3	13	27	44
37		16	4	0	0	4	13	26	41	59
35	9	1	0	0	5	14	26	40	56	72
33	0	0	1	7	16	27	40	54	69	85
31	0	3	10	18	29	40	53	67	82	97
29	6	13	21	31	42	54	67	80	93	107
27	16	25	34	44	55	67	79	91	104	116
25	29	38	47	58	68	79	91	102	113	124
23	41	51	60	70	80	90	101	111	121	131

The above wind factor table is for calculation of wind required to maintain present range capability at new pressure altitude, i.e., break-even wind.

Method:

1. **Read wind factors for present and new altitudes from table.**
2. **Determine difference (new altitude wind factor minus present altitude wind factor); this difference may be negative or positive.**
3. **Break-even wind at new altitude is present altitude wind plus difference from step 2.**

Descent at .78/280/250 KIAS

PRESSURE ALTITUDE (FT)	TIME (MIN)	FUEL (KG)	DISTANCE (NM) LANDING WEIGHT (1000 KG)			
			40	50	60	70
41000	26	270	102	119	132	141
39000	25	260	96	113	126	135
37000	24	250	91	107	119	128
35000	24	250	87	102	114	123
33000	23	240	83	97	108	117
31000	22	240	78	91	102	110
29000	21	230	73	86	95	103
27000	20	230	69	80	89	96
25000	19	220	64	74	83	89
23000	18	210	59	69	76	82
21000	17	200	55	63	70	75
19000	16	190	51	58	64	69
17000	15	190	46	53	58	62
15000	14	180	42	48	53	56
10000	10	140	30	33	36	37
5000	7	110	18	19	20	21
1500	4	80	10	10	10	10

Allowances for a straight-in approach are included.

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)								
		1500	5000	10000	15000	20000	25000	30000	35000	41000
85	%N1	57.8	60.4	64.2	68.4	73.2	78.1	82.6		
	KIAS	244	244	246	247	249	251	254		
	FF/ENG	1220	1200	1200	1190	1190	1200	1220		
80	%N1	56.2	58.8	62.6	66.8	71.5	76.4	81.0	85.9	
	KIAS	237	237	238	239	242	243	246	249	
	FF/ENG	1150	1140	1130	1130	1120	1120	1140	1190	
75	%N1	54.6	57.1	60.8	65.1	69.6	74.6	79.4	84.1	
	KIAS	229	229	230	232	233	235	238	241	
	FF/ENG	1090	1070	1070	1070	1070	1050	1060	1100	
70	%N1	53.0	55.3	59.0	63.2	67.7	72.7	77.6	82.2	
	KIAS	220	222	222	224	225	227	229	232	
	FF/ENG	1030	1010	1000	1010	1000	980	990	1010	
65	%N1	51.3	53.5	57.1	61.2	65.7	70.5	75.7	80.3	
	KIAS	211	214	214	215	216	218	220	223	
	FF/ENG	960	950	930	940	930	910	920	930	
60	%N1	49.5	51.7	55.1	59.1	63.6	68.3	73.5	78.3	86.0
	KIAS	204	204	206	206	208	209	211	213	217
	FF/ENG	900	890	870	870	870	840	840	860	930
55	%N1	47.6	49.8	53.1	56.9	61.3	65.9	71.0	76.1	83.7
	KIAS	198	198	198	198	199	200	201	203	207
	FF/ENG	850	840	810	800	800	780	780	790	850
50	%N1	45.7	47.8	51.0	54.5	58.8	63.4	68.3	73.6	81.1
	KIAS	191	191	191	191	191	191	192	193	196
	FF/ENG	790	780	760	740	730	730	720	730	770
45	%N1	43.8	45.8	48.9	52.2	56.2	60.8	65.4	70.6	78.4
	KIAS	185	185	185	185	185	185	185	185	185
	FF/ENG	740	720	700	680	670	660	660	660	690
40	%N1	41.8	43.7	46.7	49.9	53.5	57.9	62.5	67.5	75.4
	KIAS	178	178	178	178	178	178	178	178	178
	FF/ENG	690	670	640	620	610	600	590	590	620

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

ADVISORY INFORMATION

Runway Surface Condition Correlation

RUNWAY CONDITION CODE	RUNWAY SURFACE CONDITION DESCRIPTION	REPORTED BRAKING ACTION
6	Dry	Dry
5	Wet (Smooth, Grooved or PFC) or Frost 3 mm (0.12 inches) or less of: Water, Slush, Dry Snow or Wet Snow	Good
4	Compacted Snow at or below -15°C OAT	Good to Medium
3	Wet (Slippery), Dry Snow or Wet Snow (any depth) over Compacted Snow Greater than 3 mm (0.12 inches) of : Dry Snow or Wet Snow Compacted Snow at OAT warmer than -15°C	Medium
2	Greater than 3 mm (0.12 inches) of: Water or Slush	Medium to Poor
1	Ice	Poor
0	Wet Ice, Water on top of Compacted Snow, Dry Snow or Wet Snow over Ice	Nil

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 15

LANDING DISTANCE AND ADJUSTMENTS (M)

Dry Runway

BRAKING CONFIGURATION	REF DIST 65000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 65000 KG	ALT ADJ PER 1000 FT STD/HIGH*	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABOVE VREF15	REVERSE THRUST ADJ ONE REV	REVERSE THRUST ADJ NO REV
MAX MANUAL	1470	85/-90	40/50	-65/215	15/-15	40/-40	65	30	45
AUTOBRAKE MAX	1645	90/-100	45/55	-70/235	5/0	45/-45	85	5	10
AUTOBRAKE 3	2220	135/-150	65/85	-105/345	0/0	65/-65	130	0	0
AUTOBRAKE 2	2795	185/-200	90/115	-140/460	15/-35	85/-90	145	30	30
AUTOBRAKE 1	3090	220/-235	105/140	-160/540	65/-75	100/-100	140	235	265

Good Reported Braking Action

BRAKING CONFIGURATION	REF DIST 65000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 65000 KG	ALT ADJ PER 1000 FT STD/HIGH*	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABOVE VREF15	REVERSE THRUST ADJ ONE REV	REVERSE THRUST ADJ NO REV
MAX MANUAL	1850	135/-135	65/90	-100/355	40/-35	60/-60	95	95	190
AUTOBRAKE MAX	1870	135/-135	65/90	-100/350	35/-30	60/-60	105	100	200
AUTOBRAKE 3	2250	135/-150	65/85	-110/360	10/-10	70/-70	130	0	0
AUTOBRAKE 2	2800	185/-205	90/115	-140/470	25/-40	90/-90	145	30	30
AUTOBRAKE 1	3090	220/-235	105/140	-160/540	75/-80	100/-100	140	235	265

Good To Medium Reported Braking Action

BRAKING CONFIGURATION	REF DIST 65000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 65000 KG	ALT ADJ PER 1000 FT STD/HIGH*	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABOVE VREF15	REVERSE THRUST ADJ ONE REV	REVERSE THRUST ADJ NO REV
MAX MANUAL	2030	135/-140	70/90	-110/380	55/-45	65/-65	95	130	270
AUTOBRAKE MAX	2050	135/-140	70/95	-105/375	55/-45	65/-65	105	135	275
AUTOBRAKE 3	2275	140/-155	70/90	-110/380	25/-15	70/-70	130	25	90
AUTOBRAKE 2	2800	185/-205	90/115	-140/470	25/-40	90/-90	145	30	30
AUTOBRAKE 1	3090	220/-235	105/140	-160/540	75/-80	100/-100	140	235	265

Medium Reported Braking Action

BRAKING CONFIGURATION	REF DIST 65000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 65000 KG	ALT ADJ PER 1000 FT STD/HIGH*	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABOVE VREF15	REVERSE THRUST ADJ ONE REV	REVERSE THRUST ADJ NO REV
MAX MANUAL	2165	140/-145	70/95	-115/400	70/-55	65/-65	95	170	365
AUTOBRAKE MAX	2185	140/-150	70/95	-115/395	65/-55	65/-65	105	170	375
AUTOBRAKE 3	2330	145/-155	70/95	-120/410	45/-30	70/-70	130	80	245
AUTOBRAKE 2	2800	185/-200	90/115	-140/475	40/-40	90/-90	145	40	70
AUTOBRAKE 1	3090	220/-235	105/140	-160/540	75/-80	100/-100	140	235	265

ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF15	ONE REV	NO REV

Medium To Poor Reported Braking Action

MAX MANUAL	2490	195/-190	95/135	-145/525	100/-80	85/-85	115	305	755
AUTOBRAKE MAX	2505	195/-195	100/135	-145/525	110/-90	85/-85	115	310	760
AUTOBRAKE 3	2505	195/-175	100/135	-140/525	110/-75	85/-85	120	310	760
AUTOBRAKE 2	2870	185/-205	90/125	-140/470	55/-60	85/-90	130	75	405
AUTOBRAKE 1	3125	220/-235	110/140	-160/540	85/-85	100/-100	135	250	350

Poor Reported Braking Action

MAX MANUAL	3185	230/-230	115/155	-200/730	285/-180	100/-100	115	635	1790
AUTOBRAKE MAX	3200	230/-235	120/155	-200/730	290/-185	100/-100	115	640	1800
AUTOBRAKE 3	3200	230/-235	120/155	-200/730	290/-185	100/-100	120	640	1800
AUTOBRAKE 2	3320	235/-240	120/155	-205/740	270/-175	105/-105	130	530	1675
AUTOBRAKE 1	3430	245/-255	125/165	-210/760	275/-175	110/-110	135	585	1590

Reference distance is based on sea level, standard day, no wind or slope, VREF15, two-engine detent No. 2 reverse thrust, and auto or manual speedbrakes.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
All reference distances and adjustments shown have been increased by 15%.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF30	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1365	80/-85	35/45	-65/210	15/-15	35/-35	65	20	35
AUTOBRAKE MAX	1535	85/-95	40/50	-70/225	5/0	40/-40	80	5	10
AUTOBRAKE 3	2050	120/-140	60/75	-100/335	0/0	60/-60	125	0	0
AUTOBRAKE 2	2570	165/-185	80/105	-135/445	15/-35	80/-80	130	35	35
AUTOBRAKE 1	2830	195/-210	95/125	-155/515	60/-75	90/-90	125	200	255
Good Reported Braking Action									
MAX MANUAL	1680	115/-120	60/80	-95/335	30/-30	55/-55	90	70	135
AUTOBRAKE MAX	1715	120/-120	60/80	-95/335	30/-30	55/-55	95	75	145
AUTOBRAKE 3	2080	125/-140	60/80	-105/340	10/-10	60/-65	125	0	0
AUTOBRAKE 2	2570	170/-185	80/105	-135/450	25/-35	80/-80	130	35	35
AUTOBRAKE 1	2830	195/-210	95/125	-155/515	65/-75	90/-90	125	200	255
Good To Medium Reported Braking Action									
MAX MANUAL	1860	120/-125	60/80	-100/360	50/-40	55/-55	90	100	210
AUTOBRAKE MAX	1895	120/-125	60/80	-100/355	45/-40	55/-55	95	105	215
AUTOBRAKE 3	2100	125/-140	60/80	-110/360	20/-15	65/-65	125	20	70
AUTOBRAKE 2	2570	170/-185	80/105	-135/450	25/-35	80/-80	130	35	35
AUTOBRAKE 1	2830	195/-210	95/125	-155/515	65/-75	90/-90	125	200	255
Medium Reported Braking Action									
MAX MANUAL	1990	125/-130	60/85	-105/380	60/-50	60/-60	90	135	290
AUTOBRAKE MAX	2025	125/-135	65/85	-110/380	60/-50	60/-60	95	140	300
AUTOBRAKE 3	2155	130/-145	65/85	-115/390	40/-25	65/-65	125	65	190
AUTOBRAKE 2	2570	170/-185	80/105	-135/455	40/-40	80/-80	130	45	65
AUTOBRAKE 1	2830	195/-210	95/125	-155/515	65/-75	90/-90	125	200	255

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF30	ONE REV	NO REV
Medium To Poor Reported Braking Action									
MAX MANUAL	2245	170/-170	85/115	-140/495	85/-70	75/-75	110	225	530
AUTOBRAKE MAX	2260	175/-175	85/120	-140/500	95/-80	80/-80	110	225	535
AUTOBRAKE 3	2270	175/-160	85/120	-130/500	95/-55	80/-75	115	225	535
AUTOBRAKE 2	2615	165/-185	80/110	-135/450	50/-50	80/-80	125	55	190
AUTOBRAKE 1	2855	195/-210	95/125	-155/520	70/-80	90/-90	120	205	275
Poor Reported Braking Action									
MAX MANUAL	2920	205/-210	105/135	-190/705	260/-165	90/-90	110	515	1400
AUTOBRAKE MAX	2935	205/-210	105/140	-190/705	270/-170	90/-95	110	520	1410
AUTOBRAKE 3	2935	210/-210	105/135	-190/705	270/-165	95/-95	115	520	1410
AUTOBRAKE 2	3045	210/-220	105/140	-195/720	250/-160	95/-95	125	435	1300
AUTOBRAKE 1	3150	220/-235	110/145	-200/735	250/-170	100/-100	120	485	1275

Reference distance is based on sea level, standard day, no wind or slope, VREF30, two-engine detent No. 2 reverse thrust, and auto or manual speedbrakes.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
All reference distances and adjustments shown have been increased by 15%.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF40	ONE REV	NO REV

Dry Runway

MAX MANUAL	1285	90/-75	35/45	-60/205	15/-10	30/-35	65	20	30
AUTOBRAKE MAX	1425	95/-85	40/50	-70/220	5/0	40/-40	80	5	10
AUTOBRAKE 3	1890	140/-125	60/75	-100/325	0/0	55/-55	120	0	0
AUTOBRAKE 2	2370	185/-170	80/100	-130/430	5/-30	75/-75	130	15	15
AUTOBRAKE 1	2630	210/-195	95/120	-150/500	50/-65	80/-85	125	155	190

Good Reported Braking Action

MAX MANUAL	1560	125/-110	55/75	-90/325	30/-25	50/-50	90	60	110
AUTOBRAKE MAX	1595	130/-110	55/80	-90/320	30/-25	50/-50	95	60	120
AUTOBRAKE 3	1915	140/-130	60/75	-100/330	10/-5	55/-60	120	0	0
AUTOBRAKE 2	2375	185/-170	80/105	-130/435	20/-30	75/-75	135	15	15
AUTOBRAKE 1	2630	210/-195	95/120	-150/500	55/-65	80/-85	125	155	190

Good To Medium Reported Braking Action

MAX MANUAL	1740	130/-115	60/80	-95/345	45/-40	50/-50	90	85	180
AUTOBRAKE MAX	1775	135/-115	60/80	-95/345	45/-40	55/-55	95	90	185
AUTOBRAKE 3	1940	140/-130	60/80	-105/350	20/-15	60/-60	120	20	70
AUTOBRAKE 2	2375	185/-170	80/105	-130/435	20/-30	75/-75	135	15	15
AUTOBRAKE 1	2630	210/-195	95/120	-150/500	55/-65	80/-85	125	155	190

Medium Reported Braking Action

MAX MANUAL	1870	135/-120	60/80	-105/365	60/-50	55/-55	90	120	255
AUTOBRAKE MAX	1905	140/-125	60/80	-105/370	60/-50	55/-55	95	125	260
AUTOBRAKE 3	1995	145/-130	65/85	-110/380	40/-25	60/-60	120	65	185
AUTOBRAKE 2	2375	185/-170	80/105	-130/440	30/-30	75/-75	135	25	45
AUTOBRAKE 1	2630	210/-195	95/120	-150/500	55/-65	80/-85	125	155	190

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF40	ONE REV	NO REV

Medium To Poor Reported Braking Action

MAX MANUAL	2080	180/-160	80/110	-135/485	80/-65	70/-70	105	185	420
AUTOBRAKE MAX	2100	185/-160	85/115	-135/485	90/-75	70/-75	110	190	430
AUTOBRAKE 3	2105	185/-150	85/115	-130/485	90/-55	75/-70	115	190	430
AUTOBRAKE 2	2420	180/-175	80/105	-130/440	45/-45	75/-75	120	30	125
AUTOBRAKE 1	2655	210/-195	95/120	-150/505	60/-75	80/-85	120	160	200

Poor Reported Braking Action

MAX MANUAL	2750	215/-195	100/130	-185/695	255/-160	85/-85	105	460	1225
AUTOBRAKE MAX	2770	220/-200	100/135	-185/695	265/-165	85/-85	110	465	1235
AUTOBRAKE 3	2770	220/-200	105/135	-185/695	265/-160	85/-85	115	465	1235
AUTOBRAKE 2	2860	225/-205	105/135	-190/705	245/-155	90/-90	120	385	1150
AUTOBRAKE 1	2950	235/-215	110/140	-195/720	245/-160	95/-95	120	430	1110

Reference distance is based on sea level, standard day, no wind or slope, VREF40, two-engine detent No. 2 reverse thrust, and auto or manual speedbrakes.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
All reference distances and adjustments shown have been increased by 15%.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Airspeed Unreliable (Flaps 15)

VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1385	90/-80	35/45	-60/190	15/-15	35/-35	N/A	30	50
AUTOBRAKE MAX	1575	85/-90	40/50	-65/210	0/0	45/-45	N/A	5	10
AUTOBRAKE 2	2650	170/-185	85/110	-125/415	30/-45	80/-85	N/A	95	95

Good Reported Braking Action

MAX MANUAL	1760	125/-120	65/85	-90/320	35/-30	60/-60	N/A	105	210
AUTOBRAKE MAX	1790	125/-120	65/85	-90/315	35/-30	60/-60	N/A	110	220
AUTOBRAKE 2	2660	170/-190	90/115	-130/420	40/-50	85/-85	N/A	100	100

Good To Medium Reported Braking Action

MAX MANUAL	1915	125/-125	65/90	-100/340	50/-40	60/-60	N/A	135	280
AUTOBRAKE MAX	1945	125/-125	65/90	-95/335	50/-40	60/-60	N/A	140	290
AUTOBRAKE 2	2660	170/-190	90/115	-130/420	40/-50	85/-85	N/A	100	100

Medium Reported Braking Action

MAX MANUAL	2030	130/-130	65/90	-100/360	60/-50	60/-60	N/A	170	370
AUTOBRAKE MAX	2055	130/-135	70/90	-100/355	60/-50	60/-60	N/A	175	380
AUTOBRAKE 3	2245	130/-145	70/90	-110/365	35/-25	70/-70	N/A	65	220

Medium To Poor Reported Braking Action

MAX MANUAL	2330	175/-170	90/125	-130/460	90/-75	80/-80	N/A	305	770
AUTOBRAKE MAX	2340	180/-170	90/125	-130/460	95/-80	80/-80	N/A	310	780
AUTOBRAKE 3	2350	180/-155	90/125	-120/460	95/-55	80/-80	N/A	310	785

Poor Reported Braking Action

MAX MANUAL	2915	205/-205	105/140	-175/635	245/-155	90/-90	N/A	590	1690
AUTOBRAKE MAX	2930	205/-205	110/140	-175/640	250/-160	95/-95	N/A	595	1700
AUTOBRAKE 3	2935	205/-205	110/140	-175/640	245/-150	95/-95	N/A	595	1700

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Airspeed Unreliable (Flaps 30)
VREF30

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1290	75/-75	35/40	-55/185	15/-10	35/-35	N/A	25	40
AUTOBRAKE MAX	1475	75/-85	40/50	-65/205	5/0	40/-40	N/A	0	10
AUTOBRAKE 2	2435	155/-170	80/100	-120/400	35/-40	75/-75	N/A	100	105

Good Reported Braking Action

MAX MANUAL	1605	110/-110	55/75	-85/300	30/-25	55/-50	N/A	75	150
AUTOBRAKE MAX	1645	110/-110	55/75	-85/300	30/-25	55/-55	N/A	85	165
AUTOBRAKE 2	2440	155/-170	80/105	-120/405	40/-45	75/-75	N/A	105	105

Good To Medium Reported Braking Action

MAX MANUAL	1760	110/-115	60/75	-90/320	45/-40	55/-55	N/A	105	215
AUTOBRAKE MAX	1800	115/-115	60/80	-90/320	45/-40	55/-55	N/A	110	230
AUTOBRAKE 2	2440	155/-170	80/105	-120/405	40/-45	75/-75	N/A	105	105

Medium Reported Braking Action

MAX MANUAL	1870	115/-120	60/80	-95/340	55/-45	55/-55	N/A	135	290
AUTOBRAKE MAX	1910	120/-120	60/80	-100/340	55/-45	55/-55	N/A	140	305
AUTOBRAKE 3	2085	120/-130	65/80	-105/355	30/-25	65/-65	N/A	55	170

Medium To Poor Reported Braking Action

MAX MANUAL	2115	155/-155	80/110	-120/435	80/-65	70/-70	N/A	225	545
AUTOBRAKE MAX	2125	155/-155	80/110	-120/440	85/-70	70/-75	N/A	230	555
AUTOBRAKE 3	2150	160/-140	80/110	-110/435	75/-45	70/-70	N/A	230	555

Poor Reported Braking Action

MAX MANUAL	2680	185/-185	95/125	-165/615	225/-145	85/-85	N/A	480	1320
AUTOBRAKE MAX	2695	185/-190	95/125	-170/620	230/-150	85/-85	N/A	485	1330
AUTOBRAKE 3	2710	185/-190	100/125	-170/620	225/-140	85/-85	N/A	485	1335

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Airspeed Unreliable (Flaps 40)

VREF40

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M) REF DIST 65000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 65000 KG	ALT ADJ PER 1000 FT STD/HIGH*	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABOVE VREF	REVERSE THRUST ADJ ONE REV	NO REV
Dry Runway									
MAX MANUAL	1220	80/-70	35/40	-55/180	15/-10	30/-30	N/A	20	35
AUTOBRAKE MAX	1375	90/-80	40/50	-60/200	5/0	35/-35	N/A	0	10
AUTOBRAKE 2	2270	170/-155	75/100	-115/390	25/-35	70/-70	N/A	70	70
Good Reported Braking Action									
MAX MANUAL	1495	120/-100	55/75	-85/295	30/-25	50/-50	N/A	65	125
AUTOBRAKE MAX	1545	125/-100	55/75	-80/290	30/-25	50/-50	N/A	70	135
AUTOBRAKE 2	2275	170/-155	75/100	-120/390	35/-40	70/-70	N/A	70	70
Good To Medium Reported Braking Action									
MAX MANUAL	1650	125/-105	55/75	-90/315	40/-35	50/-50	N/A	90	185
AUTOBRAKE MAX	1700	125/-105	55/75	-90/310	40/-35	50/-50	N/A	95	200
AUTOBRAKE 2	2275	170/-155	75/100	-120/390	35/-40	70/-70	N/A	70	70
Medium Reported Braking Action									
MAX MANUAL	1765	130/-110	60/75	-95/330	55/-45	50/-50	N/A	120	255
AUTOBRAKE MAX	1810	130/-115	60/80	-95/330	55/-45	55/-55	N/A	125	270
AUTOBRAKE 3	1940	140/-120	60/80	-100/345	35/-25	60/-60	N/A	55	165
Medium To Poor Reported Braking Action									
MAX MANUAL	1970	170/-140	75/105	-120/425	75/-60	65/-65	N/A	190	445
AUTOBRAKE MAX	1990	170/-145	80/105	-120/430	80/-65	70/-70	N/A	195	455
AUTOBRAKE 3	2005	170/-130	80/105	-110/425	75/-45	70/-65	N/A	195	460
Poor Reported Braking Action									
MAX MANUAL	2540	195/-175	95/120	-165/610	220/-140	80/-80	N/A	430	1160
AUTOBRAKE MAX	2555	200/-175	95/125	-165/610	230/-145	80/-80	N/A	435	1170
AUTOBRAKE 3	2565	200/-180	95/125	-165/610	225/-140	80/-80	N/A	435	1175

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

All Flaps Up Landing

VREF40 + 55

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1725	175/-90	50/80	-65/205	20/-15	45/-45	60	45	75
AUTOBRAKE MAX	2065	125/-95	55/75	-75/235	5/0	55/-60	85	5	15
AUTOBRAKE 2	3505	225/-220	125/160	-145/470	55/-70	110/-110	125	240	245
Good Reported Braking Action									
MAX MANUAL	2320	160/-140	90/120	-105/365	50/-45	80/-80	90	190	390
AUTOBRAKE MAX	2350	160/-140	90/120	-105/365	50/-40	80/-80	95	195	405
AUTOBRAKE 2	3520	225/-225	125/160	-145/475	70/-75	110/-110	125	245	255
Good To Medium Reported Braking Action									
MAX MANUAL	2475	165/-150	90/125	-110/385	60/-55	80/-80	90	220	465
AUTOBRAKE MAX	2505	165/-145	90/125	-110/385	60/-55	80/-80	95	225	480
AUTOBRAKE 2	3520	225/-225	125/160	-145/475	70/-75	110/-110	125	245	255
Medium Reported Braking Action									
MAX MANUAL	2595	170/-155	95/125	-115/405	75/-65	85/-85	90	260	565
AUTOBRAKE MAX	2625	170/-155	95/125	-115/400	75/-60	85/-85	95	265	580
AUTOBRAKE 3	3005	160/-160	95/120	-125/410	35/-25	95/-95	135	70	245
Medium To Poor Reported Braking Action									
MAX MANUAL	3075	230/-205	125/170	-150/515	120/-100	105/-105	105	525	1415
AUTOBRAKE MAX	3085	230/-205	125/170	-150/515	125/-105	105/-105	105	530	1420
AUTOBRAKE 3	3140	225/-180	125/170	-140/520	110/-70	110/-110	125	495	1395
Poor Reported Braking Action									
MAX MANUAL	3690	260/-240	145/190	-190/685	280/-185	115/-115	105	860	2540
AUTOBRAKE MAX	3700	260/-240	145/190	-190/690	285/-190	120/-120	105	860	2550
AUTOBRAKE 3	3755	255/-235	145/190	-190/690	265/-170	120/-120	125	830	2520

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTISKID INOPERATIVE (Flaps 15)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1955	120/-130	60/75	-100/345	60/-50	55/-55	80	155	345
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2275	175/-170	85/120	-135/485	95/-75	75/-75	100	300	765
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2635	190/-185	95/130	-160/585	190/-130	85/-85	100	460	1270
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2795	200/-200	100/135	-175/645	245/-155	85/-85	100	565	1640
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	2910	230/-220	115/155	-190/705	265/-165	95/-95	110	645	1950
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3520	270/-265	140/180	-260/1050	1345/-310	115/-115	110	1285	**
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

****Deceleration insufficient to stop airplane on the runway.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTISKID INOPERATIVE (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1800	110/-115	55/70	-95/330	55/-45	50/-50	75	125	275
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2065	155/-150	75/105	-125/460	85/-65	70/-70	95	225	555
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2415	170/-170	85/110	-150/565	175/-115	75/-75	95	370	990
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2565	180/-180	90/120	-170/625	230/-140	80/-80	95	460	1285
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	2655	200/-195	100/135	-180/680	240/-150	85/-85	105	510	1450
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3240	240/-240	125/160	-250/1020	1325/-290	105/-105	105	1075	**
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

****Deceleration insufficient to stop airplane on the runway.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTISKID INOPERATIVE (Flaps 40)
VREF40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1690	120/-110	55/70	-95/325	55/-45	45/-50	75	110	240
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Good Reported Braking Action									
MAX MANUAL	1920	165/-140	75/100	-120/445	80/-65	60/-60	95	190	460
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Good To Medium Reported Braking Action									
MAX MANUAL	2270	180/-155	80/110	-150/550	170/-115	70/-70	95	330	860
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Medium Reported Braking Action									
MAX MANUAL	2415	190/-170	90/115	-165/615	225/-135	75/-75	95	410	1120
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								
Medium To Poor Reported Braking Action									
MAX MANUAL	2485	215/-180	95/130	-175/665	235/-145	80/-80	100	440	1230
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								
Poor Reported Braking Action									
MAX MANUAL	3070	255/-225	120/155	-245/1015	1390/-285	100/-100	100	985	4570
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Jammed or Restricted Flight Controls (Flaps 15)
VREF15 + 10

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1385	90/-80	35/45	-60/190	15/-15	35/-35	55	30	50
AUTOBRAKE MAX	1575	85/-90	40/50	-65/210	0/0	45/-45	75	5	10
AUTOBRAKE 2	2650	170/-185	85/110	-125/415	30/-45	80/-85	115	95	95

Good Reported Braking Action

MAX MANUAL	1760	125/-120	65/85	-90/320	35/-30	60/-60	85	105	210
AUTOBRAKE MAX	1790	125/-120	65/85	-90/315	35/-30	60/-60	90	110	220
AUTOBRAKE 2	2660	170/-190	90/115	-130/420	40/-50	85/-85	115	100	100

Good To Medium Reported Braking Action

MAX MANUAL	1915	125/-125	65/90	-100/340	50/-40	60/-60	85	135	280
AUTOBRAKE MAX	1945	125/-125	65/90	-95/335	50/-40	60/-60	90	140	290
AUTOBRAKE 2	2660	170/-190	90/115	-130/420	40/-50	85/-85	115	100	100

Medium Reported Braking Action

MAX MANUAL	2030	130/-130	65/90	-100/360	60/-50	60/-60	85	170	370
AUTOBRAKE MAX	2055	130/-135	70/90	-100/355	60/-50	60/-60	90	175	380
AUTOBRAKE 3	2245	130/-145	70/90	-110/365	35/-25	70/-70	120	65	220

Medium To Poor Reported Braking Action

MAX MANUAL	2330	175/-170	90/125	-130/460	90/-75	80/-80	100	305	770
AUTOBRAKE MAX	2340	180/-170	90/125	-130/460	95/-80	80/-80	100	310	780
AUTOBRAKE 3	2350	180/-155	90/125	-120/460	95/-55	80/-80	110	310	785

Poor Reported Braking Action

MAX MANUAL	2915	205/-205	105/140	-175/635	245/-155	90/-90	100	590	1690
AUTOBRAKE MAX	2930	205/-205	110/140	-175/640	250/-160	95/-95	100	595	1700
AUTOBRAKE 3	2935	205/-205	110/140	-175/640	245/-150	95/-95	110	595	1700

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LEADING EDGE FLAPS TRANSIT (Flaps 15)
VREF15 + 15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1460	90/-85	40/50	-60/195	15/-15	40/-40	60	35	55
AUTOBRAKE MAX	1650	85/-95	45/55	-65/215	5/0	45/-45	85	5	10
AUTOBRAKE 2	2790	175/-195	90/120	-130/425	35/-50	85/-90	115	110	110
Good Reported Braking Action									
MAX MANUAL	1880	130/-130	70/95	-95/330	40/-35	65/-65	90	125	255
AUTOBRAKE MAX	1915	130/-130	70/95	-95/330	40/-35	65/-65	95	130	270
AUTOBRAKE 2	2815	180/-195	95/120	-130/430	45/-55	90/-90	120	120	120
Good To Medium Reported Braking Action									
MAX MANUAL	2035	135/-135	70/95	-100/350	55/-45	65/-65	90	155	330
AUTOBRAKE MAX	2070	135/-135	70/95	-100/350	55/-45	65/-65	95	160	340
AUTOBRAKE 2	2815	180/-195	95/120	-130/430	45/-55	90/-90	120	120	120
Medium Reported Braking Action									
MAX MANUAL	2150	135/-140	70/95	-105/370	65/-55	65/-65	90	190	420
AUTOBRAKE MAX	2185	140/-140	75/100	-105/370	65/-55	65/-65	95	200	435
AUTOBRAKE 3	2380	135/-145	70/95	-110/375	40/-25	75/-75	125	75	255
Medium To Poor Reported Braking Action									
MAX MANUAL	2470	185/-180	95/130	-135/470	100/-80	85/-85	100	350	895
AUTOBRAKE MAX	2495	185/-180	100/135	-135/475	105/-85	85/-85	100	355	905
AUTOBRAKE 3	2500	185/-160	100/135	-130/475	105/-65	85/-85	110	355	910
Poor Reported Braking Action									
MAX MANUAL	3065	215/-215	115/150	-180/650	255/-165	95/-95	100	645	1860
AUTOBRAKE MAX	3085	215/-215	115/150	-180/650	260/-170	100/-100	100	650	1870
AUTOBRAKE 3	3090	215/-215	115/150	-180/650	260/-160	100/-100	110	650	1875

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF BOTH ENGINE DRIVEN GENERATORS (Flaps 15)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	2295	150/-160	75/100	-115/385	90/-75	65/-70	115	280	655
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2690	225/-210	110/155	-150/545	145/-115	90/-90	135	545	1585
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	3090	240/-230	120/165	-180/650	260/-175	100/-100	135	755	2325
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	3265	255/-245	130/175	-195/710	330/-205	105/-105	135	900	2960
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3400	290/-270	145/200	-210/780	355/-220	115/-115	145	1055	3820
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	4085	335/-320	175/230	-290/1135	1705/-390	140/-135	145	1885	**
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

****Deceleration insufficient to stop airplane on the runway.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF BOTH ENGINE DRIVEN GENERATORS (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	2145	140/-145	70/90	-110/375	85/-70	60/-65	110	235	545
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2470	200/-190	100/135	-145/525	135/-105	85/-85	130	435	1180
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2865	215/-210	110/145	-175/630	245/-160	90/-90	130	625	1830
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	3035	230/-225	115/155	-190/690	315/-190	95/-95	130	750	2330
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3130	255/-245	130/180	-205/755	330/-205	105/-105	135	845	2780
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3800	305/-295	160/205	-280/1115	1725/-370	125/-125	135	1600	**
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

****Deceleration insufficient to stop airplane on the runway.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF BOTH ENGINE DRIVEN GENERATORS (Flaps 40)
VREF40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	2020	160/-140	70/90	-110/370	85/-70	60/-60	110	210	475
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2300	215/-175	95/130	-140/510	125/-100	75/-75	125	365	965
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2690	235/-195	105/140	-170/615	240/-155	85/-85	125	550	1560
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2855	245/-210	115/150	-185/680	310/-185	90/-90	125	660	1990
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	2930	270/-225	125/170	-200/740	320/-195	100/-100	130	725	2270
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3595	320/-275	150/200	-280/1105	1810/-360	120/-120	130	1445	**
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

****Deceleration insufficient to stop airplane on the runway.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF SYSTEM A (Flaps 15)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1435	90/-85	40/50	-60/200	20/-20	40/-40	75	30	50
AUTOBRAKE MAX	1460	85/-90	40/50	-65/205	10/-5	40/-40	80	25	45
AUTOBRAKE 2	2460	160/-175	75/100	-120/405	0/0	80/-80	150	0	0

Good Reported Braking Action

MAX MANUAL	1890	145/-140	70/100	-100/355	55/-45	65/-65	115	165	310
AUTOBRAKE MAX	1845	145/-140	70/100	-100/355	60/-50	65/-65	115	155	290
AUTOBRAKE 2	2480	165/-180	80/105	-130/430	30/-15	80/-85	155	10	10

Good To Medium Reported Braking Action

MAX MANUAL	2055	150/-145	75/100	-105/370	70/-60	65/-65	115	205	400
AUTOBRAKE MAX	2010	145/-145	75/100	-105/370	75/-65	65/-65	115	195	380
AUTOBRAKE 2	2480	165/-180	80/105	-130/430	30/-15	80/-85	155	10	10

Medium Reported Braking Action

MAX MANUAL	2185	150/-150	75/105	-110/390	85/-70	70/-65	115	250	530
AUTOBRAKE MAX	2140	150/-145	75/105	-110/390	90/-75	70/-70	115	240	510
AUTOBRAKE 3	2145	150/-145	75/105	-110/390	90/-55	70/-70	120	240	510

Medium To Poor Reported Braking Action

MAX MANUAL	2525	210/-200	105/145	-145/505	130/-100	90/-85	130	485	1275
AUTOBRAKE MAX	2510	210/-195	105/145	-145/505	140/-110	90/-90	130	480	1260
AUTOBRAKE 3	2510	210/-195	105/145	-145/505	140/-110	90/-90	130	480	1260

Poor Reported Braking Action

MAX MANUAL	3170	240/-235	125/165	-190/685	310/-195	100/-100	130	855	2610
AUTOBRAKE MAX	3155	240/-235	125/165	-190/685	320/-205	100/-100	130	850	2595
AUTOBRAKE 3	3155	240/-235	125/165	-190/685	320/-205	100/-100	130	850	2595

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF SYSTEM A (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1315	80/-80	35/45	-60/195	20/-15	35/-35	70	25	40
AUTOBRAKE MAX	1355	80/-85	35/45	-60/200	10/-5	35/-35	75	20	35
AUTOBRAKE 2	2265	145/-160	70/90	-115/390	0/0	70/-70	145	0	0

Good Reported Braking Action

MAX MANUAL	1690	125/-125	60/85	-95/330	45/-40	55/-55	105	115	205
AUTOBRAKE MAX	1655	125/-120	60/85	-95/330	50/-45	55/-55	105	110	195
AUTOBRAKE 2	2265	145/-160	70/95	-120/400	20/0	70/-75	145	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1855	130/-125	65/85	-100/350	60/-50	60/-60	105	150	285
AUTOBRAKE MAX	1820	130/-125	65/85	-100/350	65/-55	60/-60	105	145	275
AUTOBRAKE 2	2265	145/-160	70/95	-120/400	20/0	70/-75	145	0	0

Medium Reported Braking Action

MAX MANUAL	1980	130/-135	65/90	-105/365	75/-60	60/-60	105	190	395
AUTOBRAKE MAX	1950	135/-130	65/90	-105/365	80/-65	60/-60	105	185	385
AUTOBRAKE 3	1960	130/-130	65/90	-105/360	75/-50	60/-60	110	185	385

Medium To Poor Reported Braking Action

MAX MANUAL	2250	180/-175	90/125	-135/480	110/-85	80/-75	120	345	815
AUTOBRAKE MAX	2245	180/-175	90/125	-135/475	115/-95	80/-80	120	340	810
AUTOBRAKE 3	2245	180/-175	90/125	-135/475	115/-95	80/-80	120	340	810

Poor Reported Braking Action

MAX MANUAL	2880	210/-210	110/140	-180/660	285/-175	90/-90	120	670	1910
AUTOBRAKE MAX	2870	210/-210	110/145	-180/660	290/-185	90/-90	120	665	1900
AUTOBRAKE 3	2870	210/-210	110/145	-180/660	290/-185	90/-90	120	665	1900

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF SYSTEM A (Flaps 40)
VREF40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1230	90/-75	35/45	-60/190	15/-15	30/-35	70	20	30
AUTOBRAKE MAX	1260	95/-80	35/45	-60/195	10/-5	35/-35	75	20	30
AUTOBRAKE 2	2075	170/-145	70/90	-110/375	0/0	65/-65	140	0	0

Good Reported Braking Action

MAX MANUAL	1550	140/-110	60/80	-90/315	40/-35	50/-50	100	90	155
AUTOBRAKE MAX	1525	140/-110	60/80	-90/315	45/-40	50/-50	105	85	150
AUTOBRAKE 2	2075	170/-145	70/90	-115/380	15/0	65/-65	140	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1715	145/-115	60/85	-95/335	55/-45	55/-55	100	120	235
AUTOBRAKE MAX	1690	145/-115	60/85	-95/335	60/-50	55/-55	105	120	225
AUTOBRAKE 2	2075	170/-145	70/90	-115/380	15/0	65/-65	140	0	0

Medium Reported Braking Action

MAX MANUAL	1845	145/-125	65/85	-100/350	70/-60	55/-55	100	160	330
AUTOBRAKE MAX	1820	150/-120	65/85	-100/350	75/-65	55/-55	100	160	320
AUTOBRAKE 3	1830	150/-120	65/85	-100/345	70/-50	55/-55	105	160	325

Medium To Poor Reported Braking Action

MAX MANUAL	2065	195/-160	85/115	-130/460	100/-80	70/-70	115	270	610
AUTOBRAKE MAX	2060	195/-160	85/120	-130/460	105/-85	70/-70	115	270	605
AUTOBRAKE 3	2060	195/-160	85/120	-130/460	105/-85	70/-70	115	270	605

Poor Reported Braking Action

MAX MANUAL	2685	225/-195	105/135	-175/645	275/-170	85/-85	115	575	1585
AUTOBRAKE MAX	2680	225/-195	105/135	-175/645	280/-175	85/-85	115	575	1585
AUTOBRAKE 3	2680	225/-195	105/135	-175/645	280/-175	85/-85	115	575	1585

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF SYSTEM A AND SYSTEM B (Flaps 15)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1865	115/-115	55/70	-85/270	50/-45	50/-50	115	20	95
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2510	190/-185	95/135	-135/465	120/-95	85/-85	155	140	590
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2725	195/-190	100/135	-145/495	145/-115	90/-85	155	205	770
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2880	205/-195	105/140	-145/520	170/-130	90/-85	155	285	1025
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3255	260/-245	130/185	-180/630	230/-170	110/-105	160	495	2230
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3995	300/-290	160/210	-240/885	565/-305	125/-125	160	1065	4885
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

LOSS OF SYSTEM B (Flaps 15)

VREF15

BRAKING CONFIGURATION	REF DIST 65000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 65000 KG	ALT ADJ PER 1000 FT STD/HIGH*	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABOVE VREF	REVERSE THRUST ADJ ONE REV	REVERSE THRUST ADJ NO REV
Dry Runway									
MAX MANUAL	1470	90/-90	40/50	-65/220	25/-20	40/-40	70	45	75
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Good Reported Braking Action									
MAX MANUAL	1860	140/-135	70/95	-105/365	50/-45	65/-65	100	155	300
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Good To Medium Reported Braking Action									
MAX MANUAL	2050	145/-140	70/95	-110/390	75/-60	65/-65	100	200	415
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								
Medium Reported Braking Action									
MAX MANUAL	2180	150/-150	75/100	-115/415	90/-75	65/-65	100	250	555
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								
Medium To Poor Reported Braking Action									
MAX MANUAL	2450	195/-190	95/135	-145/515	125/-95	85/-85	110	410	1025
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								
Poor Reported Braking Action									
MAX MANUAL	3105	230/-230	120/155	-200/745	365/-205	100/-100	110	810	2495
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
MANUAL REVERSION (Flaps 15)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1865	115/-115	55/70	-85/270	50/-45	50/-50	115	20	95
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2510	190/-185	95/135	-135/465	120/-95	85/-85	155	140	590
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2725	195/-190	100/135	-145/495	145/-115	90/-85	155	205	770
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2880	205/-195	105/140	-145/520	170/-130	90/-85	155	285	1025
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3255	260/-245	130/185	-180/630	230/-170	110/-105	160	495	2230
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3995	300/-290	160/210	-240/885	565/-305	125/-125	160	1065	4885
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
One Engine Inoperative Landing (Flaps 15)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1285	85/-80	35/40	-55/190	15/-15	35/-35	60	0	20
AUTOBRAKE MAX	1430	80/-90	35/45	-65/205	5/0	40/-40	75	0	5
AUTOBRAKE 2	2460	155/-175	75/100	-120/405	0/-5	80/-80	150	0	0
Good Reported Braking Action									
MAX MANUAL	1645	125/-120	60/80	-95/330	40/-35	55/-55	90	0	95
AUTOBRAKE MAX	1670	125/-120	60/80	-90/325	35/-30	60/-55	95	0	100
AUTOBRAKE 2	2460	160/-175	75/100	-120/410	10/-5	80/-80	150	0	0
Good To Medium Reported Braking Action									
MAX MANUAL	1825	125/-125	60/85	-100/345	55/-45	60/-60	90	0	130
AUTOBRAKE MAX	1845	125/-125	60/85	-95/345	55/-45	60/-60	95	0	135
AUTOBRAKE 2	2460	160/-175	75/100	-120/410	10/-5	80/-80	150	0	0
Medium Reported Braking Action									
MAX MANUAL	1965	130/-130	65/85	-105/365	70/-55	60/-60	90	0	180
AUTOBRAKE MAX	1985	130/-135	65/85	-105/360	70/-55	60/-60	95	0	185
AUTOBRAKE 3	2055	130/-140	65/85	-105/360	50/-35	65/-65	115	0	140
Medium To Poor Reported Braking Action									
MAX MANUAL	2325	190/-185	95/125	-145/515	115/-90	85/-85	115	0	390
AUTOBRAKE MAX	2330	195/-190	95/130	-145/515	125/-100	85/-85	115	0	395
AUTOBRAKE 3	2335	195/-185	95/130	-145/520	120/-90	85/-85	120	0	395
Poor Reported Braking Action									
MAX MANUAL	3090	220/-225	110/145	-195/700	335/-205	100/-100	115	0	915
AUTOBRAKE MAX	3100	225/-230	110/145	-195/700	345/-210	100/-100	115	0	915
AUTOBRAKE 3	3100	225/-230	110/145	-195/700	345/-205	100/-100	120	0	915

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

One Engine Inoperative Landing (Flaps 30)

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1190	70/-75	30/40	-55/180	15/-10	30/-30	55	0	15
AUTOBRAKE MAX	1335	75/-80	35/45	-60/200	5/0	35/-35	70	0	5
AUTOBRAKE 2	2260	145/-160	70/90	-115/390	0/-10	70/-70	140	0	0

Good Reported Braking Action

MAX MANUAL	1485	110/-105	50/70	-85/305	30/-25	50/-50	85	0	65
AUTOBRAKE MAX	1525	110/-110	55/70	-85/305	30/-25	50/-50	90	0	70
AUTOBRAKE 2	2260	145/-160	70/90	-115/390	10/-10	70/-70	140	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1660	110/-110	55/70	-90/325	45/-40	50/-50	85	0	100
AUTOBRAKE MAX	1695	110/-115	55/75	-90/325	45/-40	55/-50	90	0	105
AUTOBRAKE 2	2260	145/-160	70/90	-115/390	10/-10	70/-70	140	0	0

Medium Reported Braking Action

MAX MANUAL	1795	115/-120	55/75	-95/345	60/-50	55/-55	80	0	140
AUTOBRAKE MAX	1825	115/-125	55/75	-100/340	60/-50	55/-55	90	0	150
AUTOBRAKE 3	1895	120/-130	60/75	-100/345	45/-30	60/-60	110	0	105

Medium To Poor Reported Braking Action

MAX MANUAL	2065	165/-165	80/110	-135/480	95/-75	75/-75	105	0	265
AUTOBRAKE MAX	2075	170/-165	80/110	-135/480	100/-80	75/-75	105	0	270
AUTOBRAKE 3	2085	170/-160	80/110	-135/480	95/-75	75/-75	110	0	270

Poor Reported Braking Action

MAX MANUAL	2785	195/-200	95/125	-180/665	300/-180	90/-90	105	0	695
AUTOBRAKE MAX	2795	200/-205	100/125	-180/670	305/-185	90/-90	105	0	700
AUTOBRAKE 3	2810	200/-205	100/130	-185/670	300/-185	90/-90	110	0	705

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILERS (Flaps 15)
VREF15

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1505	95/-95	40/55	-65/210	25/-20	40/-40	90	60	90
AUTOBRAKE MAX	1480	90/-95	40/55	-65/205	15/-10	40/-40	85	55	85
AUTOBRAKE 2	2460	160/-175	75/100	-120/405	0/0	80/-80	150	0	0
Good Reported Braking Action									
MAX MANUAL	1980	160/-150	80/110	-105/370	65/-55	70/-70	130	225	500
AUTOBRAKE MAX	1920	155/-150	80/110	-105/365	75/-60	70/-70	130	210	460
AUTOBRAKE 2	2525	170/-180	80/105	-130/435	35/-20	85/-85	160	25	130
Good To Medium Reported Braking Action									
MAX MANUAL	2155	160/-155	80/110	-110/385	85/-70	70/-70	130	265	600
AUTOBRAKE MAX	2090	160/-155	80/110	-110/385	90/-75	70/-70	130	250	560
AUTOBRAKE 2	2525	170/-180	80/105	-130/435	35/-20	85/-85	160	25	135
Medium Reported Braking Action									
MAX MANUAL	2285	165/-165	85/115	-115/400	100/-80	70/-70	130	320	755
AUTOBRAKE MAX	2225	165/-160	85/115	-115/400	105/-85	70/-70	130	305	715
AUTOBRAKE 3	2225	165/-155	85/115	-115/400	105/-85	70/-70	130	305	715
Medium To Poor Reported Braking Action									
MAX MANUAL	2625	230/-210	115/160	-150/525	150/-115	95/-95	145	595	1870
AUTOBRAKE MAX	2595	225/-210	115/160	-150/525	160/-125	95/-95	145	585	1825
AUTOBRAKE 3	2595	225/-210	115/160	-150/525	160/-125	95/-95	145	585	1825
Poor Reported Braking Action									
MAX MANUAL	3290	260/-255	135/180	-195/705	340/-215	105/-105	145	1010	3450
AUTOBRAKE MAX	3265	260/-250	135/180	-195/700	350/-220	105/-105	145	995	3410
AUTOBRAKE 3	3265	260/-250	135/180	-195/700	350/-220	105/-105	145	995	3410

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILERS (Flaps 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1435	85/-90	40/50	-65/205	25/-25	40/-40	95	55	85
AUTOBRAKE MAX	1395	85/-90	40/50	-65/205	15/-10	40/-40	85	50	80
AUTOBRAKE 2	2265	145/-160	70/90	-115/390	0/0	70/-70	145	0	0

Good Reported Braking Action

MAX MANUAL	1835	140/-140	70/100	-100/350	60/-50	65/-65	125	185	395
AUTOBRAKE MAX	1780	140/-135	70/100	-100/350	70/-55	65/-65	130	170	365
AUTOBRAKE 2	2315	155/-165	75/100	-125/415	35/-15	75/-75	155	20	95

Good To Medium Reported Braking Action

MAX MANUAL	2010	145/-145	70/100	-105/370	80/-65	65/-65	125	225	495
AUTOBRAKE MAX	1955	145/-140	70/100	-105/365	85/-70	65/-65	130	210	460
AUTOBRAKE 2	2315	155/-165	75/100	-125/415	35/-15	75/-75	155	20	105

Medium Reported Braking Action

MAX MANUAL	2145	150/-150	75/100	-110/385	95/-75	65/-65	125	275	640
AUTOBRAKE MAX	2085	150/-145	75/105	-110/385	100/-80	65/-65	130	260	605
AUTOBRAKE 3	2085	150/-145	75/105	-110/385	100/-80	65/-65	130	260	605

Medium To Poor Reported Braking Action

MAX MANUAL	2405	205/-190	100/140	-140/505	135/-105	85/-85	140	465	1345
AUTOBRAKE MAX	2380	205/-190	100/140	-140/505	145/-110	85/-85	135	455	1310
AUTOBRAKE 3	2380	205/-190	100/140	-140/505	145/-110	85/-85	135	455	1310

Poor Reported Braking Action

MAX MANUAL	3065	235/-235	120/160	-190/685	330/-205	100/-100	140	845	2725
AUTOBRAKE MAX	3040	235/-230	120/160	-190/685	335/-210	100/-100	135	835	2690
AUTOBRAKE 3	3040	235/-230	120/160	-190/685	335/-210	100/-100	135	835	2690

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

SPOILERS (Flaps 40)

VREF40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1360	100/-85	40/55	-65/205	25/-25	35/-35	100	50	75
AUTOBRAKE MAX	1315	100/-85	40/50	-60/200	15/-15	35/-35	90	45	70
AUTOBRAKE 2	2075	170/-145	70/90	-110/375	0/0	65/-65	140	0	0

Good Reported Braking Action

MAX MANUAL	1710	165/-125	70/95	-95/340	60/-50	60/-60	125	155	325
AUTOBRAKE MAX	1660	165/-125	70/95	-95/340	65/-55	60/-60	130	145	300
AUTOBRAKE 2	2125	180/-150	75/95	-120/400	35/-15	70/-70	150	20	80

Good To Medium Reported Braking Action

MAX MANUAL	1885	170/-130	70/95	-100/355	75/-60	60/-60	125	195	420
AUTOBRAKE MAX	1835	170/-130	70/100	-100/355	85/-65	60/-60	130	185	395
AUTOBRAKE 2	2125	180/-150	75/95	-120/400	35/-15	70/-70	150	20	105

Medium Reported Braking Action

MAX MANUAL	2020	175/-140	75/100	-110/375	95/-75	60/-60	125	245	560
AUTOBRAKE MAX	1970	175/-140	75/100	-105/375	100/-80	60/-60	130	230	530
AUTOBRAKE 3	1970	175/-140	75/100	-105/375	100/-80	60/-60	130	230	530

Medium To Poor Reported Braking Action

MAX MANUAL	2225	225/-175	100/135	-135/490	125/-95	80/-80	135	385	1045
AUTOBRAKE MAX	2205	225/-175	100/135	-135/490	135/-105	80/-80	135	375	1020
AUTOBRAKE 3	2205	225/-175	100/135	-135/490	135/-105	80/-80	135	375	1020

Poor Reported Braking Action

MAX MANUAL	2885	255/-215	120/155	-185/675	325/-200	95/-95	135	745	2305
AUTOBRAKE MAX	2860	255/-215	120/155	-185/675	330/-205	95/-95	135	735	2280
AUTOBRAKE 3	2860	255/-215	120/155	-185/675	330/-205	95/-95	135	735	2280

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Stabilizer Trim Inoperative (Flaps 15)

VREF15 + 10

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1385	90/-80	35/45	-60/190	15/-15	35/-35	55	30	50
AUTOBRAKE MAX	1575	85/-90	40/50	-65/210	0/0	45/-45	75	5	10
AUTOBRAKE 2	2650	170/-185	85/110	-125/415	30/-45	80/-85	115	95	95

Good Reported Braking Action

MAX MANUAL	1760	125/-120	65/85	-90/320	35/-30	60/-60	85	105	210
AUTOBRAKE MAX	1790	125/-120	65/85	-90/315	35/-30	60/-60	90	110	220
AUTOBRAKE 2	2660	170/-190	90/115	-130/420	40/-50	85/-85	115	100	100

Good To Medium Reported Braking Action

MAX MANUAL	1915	125/-125	65/90	-100/340	50/-40	60/-60	85	135	280
AUTOBRAKE MAX	1945	125/-125	65/90	-95/335	50/-40	60/-60	90	140	290
AUTOBRAKE 2	2660	170/-190	90/115	-130/420	40/-50	85/-85	115	100	100

Medium Reported Braking Action

MAX MANUAL	2030	130/-130	65/90	-100/360	60/-50	60/-60	85	170	370
AUTOBRAKE MAX	2055	130/-135	70/90	-100/355	60/-50	60/-60	90	175	380
AUTOBRAKE 3	2245	130/-145	70/90	-110/365	35/-25	70/-70	120	65	220

Medium To Poor Reported Braking Action

MAX MANUAL	2330	175/-170	90/125	-130/460	90/-75	80/-80	100	305	770
AUTOBRAKE MAX	2340	180/-170	90/125	-130/460	95/-80	80/-80	100	310	780
AUTOBRAKE 3	2350	180/-155	90/125	-120/460	95/-55	80/-80	110	310	785

Poor Reported Braking Action

MAX MANUAL	2915	205/-205	105/140	-175/635	245/-155	90/-90	100	590	1690
AUTOBRAKE MAX	2930	205/-205	110/140	-175/640	250/-160	95/-95	100	595	1700
AUTOBRAKE 3	2935	205/-205	110/140	-175/640	245/-150	95/-95	110	595	1700

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Trailing Edge Flap Asymmetry (1 ≤ Flap Lever < 15)
VREF40 + 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1440	115/-80	40/50	-60/195	15/-15	35/-40	55	30	55
AUTOBRAKE MAX	1665	95/-85	45/60	-65/215	0/0	45/-45	80	5	10
AUTOBRAKE 2	2805	190/-185	100/125	-130/425	35/-50	85/-90	115	125	125

Good Reported Braking Action

MAX MANUAL	1850	135/-120	70/95	-95/325	35/-35	60/-60	85	120	240
AUTOBRAKE MAX	1865	135/-115	70/95	-90/325	35/-30	60/-60	90	120	250
AUTOBRAKE 2	2805	190/-185	100/125	-130/430	45/-50	90/-90	115	125	125

Good To Medium Reported Braking Action

MAX MANUAL	2005	140/-125	70/95	-100/345	50/-45	65/-65	85	150	315
AUTOBRAKE MAX	2020	140/-125	70/95	-100/345	50/-40	65/-65	90	150	320
AUTOBRAKE 2	2805	190/-185	100/125	-130/430	45/-50	90/-90	115	125	125

Medium Reported Braking Action

MAX MANUAL	2115	145/-130	75/100	-105/365	60/-50	65/-65	85	185	405
AUTOBRAKE MAX	2130	145/-130	75/100	-105/360	60/-50	65/-65	90	185	415
AUTOBRAKE 3	2370	145/-135	75/100	-110/370	30/-25	75/-75	120	60	215

Medium To Poor Reported Braking Action

MAX MANUAL	2455	195/-170	100/135	-130/465	95/-75	85/-85	100	350	905
AUTOBRAKE MAX	2460	195/-170	100/135	-130/465	100/-80	85/-85	100	350	910
AUTOBRAKE 3	2475	195/-145	100/135	-120/465	95/-50	85/-85	110	345	905

Poor Reported Braking Action

MAX MANUAL	3040	220/-205	115/150	-175/645	245/-155	95/-95	100	650	1895
AUTOBRAKE MAX	3040	225/-205	115/155	-175/645	250/-165	95/-95	100	650	1895
AUTOBRAKE 3	3055	225/-200	115/155	-175/645	245/-150	95/-95	110	645	1895

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Trailing Edge Flap Asymmetry (Flap Lever 15 or 25)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1275	80/-80	35/40	-55/185	15/-10	35/-35	55	25	40
AUTOBRAKE MAX	1430	80/-90	35/45	-65/205	0/0	40/-40	75	5	10
AUTOBRAKE 2	2415	160/-175	80/100	-120/400	20/-35	75/-75	120	40	40

Good Reported Braking Action

MAX MANUAL	1595	115/-115	55/80	-85/305	30/-30	55/-55	85	85	175
AUTOBRAKE MAX	1615	115/-115	55/80	-85/305	30/-25	55/-55	90	90	180
AUTOBRAKE 2	2420	160/-175	80/100	-120/405	30/-35	75/-75	125	40	40

Good To Medium Reported Braking Action

MAX MANUAL	1755	120/-120	60/80	-95/325	45/-40	55/-55	85	115	245
AUTOBRAKE MAX	1770	120/-120	60/80	-90/325	45/-40	55/-55	90	120	250
AUTOBRAKE 2	2420	160/-175	80/100	-120/405	30/-35	75/-75	125	40	40

Medium Reported Braking Action

MAX MANUAL	1865	125/-125	60/80	-95/345	55/-50	55/-55	85	150	330
AUTOBRAKE MAX	1885	125/-125	60/85	-100/340	55/-45	55/-55	90	155	340
AUTOBRAKE 3	2020	125/-135	60/80	-105/355	35/-25	60/-60	115	65	220

Medium To Poor Reported Braking Action

MAX MANUAL	2135	170/-165	85/115	-125/445	85/-70	75/-75	100	270	675
AUTOBRAKE MAX	2150	170/-165	85/115	-125/450	90/-75	75/-75	100	270	685
AUTOBRAKE 3	2150	170/-150	85/115	-115/450	90/-55	75/-75	100	270	685

Poor Reported Braking Action

MAX MANUAL	2720	195/-195	100/130	-170/625	235/-150	85/-85	100	555	1595
AUTOBRAKE MAX	2735	200/-200	100/135	-170/625	245/-155	85/-85	100	560	1605
AUTOBRAKE 3	2735	200/-200	100/135	-170/625	245/-150	85/-85	100	560	1605

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Trailing Edge Flap Asymmetry (Flap Lever 30)

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1185	70/-70	30/40	-55/180	10/-10	30/-30	55	20	35
AUTOBRAKE MAX	1335	70/-80	35/45	-60/195	0/0	35/-35	70	0	10
AUTOBRAKE 2	2220	145/-160	70/90	-115/385	20/-35	70/-70	110	40	40
Good Reported Braking Action									
MAX MANUAL	1450	105/-100	50/70	-80/290	25/-25	45/-45	80	65	125
AUTOBRAKE MAX	1485	105/-105	50/70	-80/285	25/-25	50/-50	85	70	135
AUTOBRAKE 2	2225	145/-160	70/90	-115/390	25/-35	70/-70	110	40	40
Good To Medium Reported Braking Action									
MAX MANUAL	1605	105/-105	50/70	-90/310	40/-35	50/-50	80	90	190
AUTOBRAKE MAX	1640	105/-110	55/70	-85/305	40/-35	50/-50	85	95	195
AUTOBRAKE 2	2225	145/-160	70/90	-115/390	25/-35	70/-70	110	40	40
Medium Reported Braking Action									
MAX MANUAL	1720	110/-115	55/70	-95/330	50/-45	50/-50	75	120	260
AUTOBRAKE MAX	1750	110/-115	55/75	-95/325	50/-45	50/-50	85	125	270
AUTOBRAKE 3	1870	115/-125	55/75	-100/340	30/-20	55/-55	110	55	170
Medium To Poor Reported Braking Action									
MAX MANUAL	1930	150/-145	75/100	-120/425	75/-60	65/-65	95	200	475
AUTOBRAKE MAX	1945	150/-150	75/100	-120/425	80/-65	65/-65	95	200	480
AUTOBRAKE 3	1960	150/-135	75/100	-110/425	75/-45	65/-65	100	200	480
Poor Reported Braking Action									
MAX MANUAL	2500	175/-180	90/115	-165/605	220/-140	80/-80	95	450	1250
AUTOBRAKE MAX	2515	180/-180	90/120	-165/605	225/-145	80/-80	95	455	1255
AUTOBRAKE 3	2520	180/-180	90/120	-165/610	225/-140	80/-80	100	455	1260

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Trailing Edge Flap Disagree (1 ≤ Indicated Flaps < 15)
VREF40 + 30

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1440	115/-80	40/50	-60/195	15/-15	35/-40	55	30	55
AUTOBRAKE MAX	1665	95/-85	45/60	-65/215	0/0	45/-45	80	5	10
AUTOBRAKE 2	2805	190/-185	100/125	-130/425	35/-50	85/-90	115	125	125

Good Reported Braking Action

MAX MANUAL	1850	135/-120	70/95	-95/325	35/-35	60/-60	85	120	240
AUTOBRAKE MAX	1865	135/-115	70/95	-90/325	35/-30	60/-60	90	120	250
AUTOBRAKE 2	2805	190/-185	100/125	-130/430	45/-50	90/-90	115	125	125

Good To Medium Reported Braking Action

MAX MANUAL	2005	140/-125	70/95	-100/345	50/-45	65/-65	85	150	315
AUTOBRAKE MAX	2020	140/-125	70/95	-100/345	50/-40	65/-65	90	150	320
AUTOBRAKE 2	2805	190/-185	100/125	-130/430	45/-50	90/-90	115	125	125

Medium Reported Braking Action

MAX MANUAL	2115	145/-130	75/100	-105/365	60/-50	65/-65	85	185	405
AUTOBRAKE MAX	2130	145/-130	75/100	-105/360	60/-50	65/-65	90	185	415
AUTOBRAKE 3	2370	145/-135	75/100	-110/370	30/-25	75/-75	120	60	215

Medium To Poor Reported Braking Action

MAX MANUAL	2455	195/-170	100/135	-130/465	95/-75	85/-85	100	350	905
AUTOBRAKE MAX	2460	195/-170	100/135	-130/465	100/-80	85/-85	100	350	910
AUTOBRAKE 3	2475	195/-145	100/135	-120/465	95/-50	85/-85	110	345	905

Poor Reported Braking Action

MAX MANUAL	3040	220/-205	115/150	-175/645	245/-155	95/-95	100	650	1895
AUTOBRAKE MAX	3040	225/-205	115/155	-175/645	250/-165	95/-95	100	650	1895
AUTOBRAKE 3	3055	225/-200	115/155	-175/645	245/-150	95/-95	110	645	1895

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Trailing Edge Flap Disagree (15 ≤ Indicated Flaps < 30)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1275	80/-80	35/40	-55/185	15/-10	35/-35	55	25	40
AUTOBRAKE MAX	1430	80/-90	35/45	-65/205	0/0	40/-40	75	5	10
AUTOBRAKE 2	2415	160/-175	80/100	-120/400	20/-35	75/-75	120	40	40

Good Reported Braking Action

MAX MANUAL	1595	115/-115	55/80	-85/305	30/-30	55/-55	85	85	175
AUTOBRAKE MAX	1615	115/-115	55/80	-85/305	30/-25	55/-55	90	90	180
AUTOBRAKE 2	2420	160/-175	80/100	-120/405	30/-35	75/-75	125	40	40

Good To Medium Reported Braking Action

MAX MANUAL	1755	120/-120	60/80	-95/325	45/-40	55/-55	85	115	245
AUTOBRAKE MAX	1770	120/-120	60/80	-90/325	45/-40	55/-55	90	120	250
AUTOBRAKE 2	2420	160/-175	80/100	-120/405	30/-35	75/-75	125	40	40

Medium Reported Braking Action

MAX MANUAL	1865	125/-125	60/80	-95/345	55/-50	55/-55	85	150	330
AUTOBRAKE MAX	1885	125/-125	60/85	-100/340	55/-45	55/-55	90	155	340
AUTOBRAKE 3	2020	125/-135	60/80	-105/355	35/-25	60/-60	115	65	220

Medium To Poor Reported Braking Action

MAX MANUAL	2135	170/-165	85/115	-125/445	85/-70	75/-75	100	270	675
AUTOBRAKE MAX	2150	170/-165	85/115	-125/450	90/-75	75/-75	100	270	685
AUTOBRAKE 3	2150	170/-150	85/115	-115/450	90/-55	75/-75	100	270	685

Poor Reported Braking Action

MAX MANUAL	2720	195/-195	100/130	-170/625	235/-150	85/-85	100	555	1595
AUTOBRAKE MAX	2735	200/-200	100/135	-170/625	245/-155	85/-85	100	560	1605
AUTOBRAKE 3	2735	200/-200	100/135	-170/625	245/-150	85/-85	100	560	1605

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Trailing Edge Flap Disagree (30 ≤ Indicated Flaps < 40)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1185	70/-70	30/40	-55/180	10/-10	30/-30	55	20	35
AUTOBRAKE MAX	1335	70/-80	35/45	-60/195	0/0	35/-35	70	0	10
AUTOBRAKE 2	2220	145/-160	70/90	-115/385	20/-35	70/-70	110	40	40

Good Reported Braking Action

MAX MANUAL	1450	105/-100	50/70	-80/290	25/-25	45/-45	80	65	125
AUTOBRAKE MAX	1485	105/-105	50/70	-80/285	25/-25	50/-50	85	70	135
AUTOBRAKE 2	2225	145/-160	70/90	-115/390	25/-35	70/-70	110	40	40

Good To Medium Reported Braking Action

MAX MANUAL	1605	105/-105	50/70	-90/310	40/-35	50/-50	80	90	190
AUTOBRAKE MAX	1640	105/-110	55/70	-85/305	40/-35	50/-50	85	95	195
AUTOBRAKE 2	2225	145/-160	70/90	-115/390	25/-35	70/-70	110	40	40

Medium Reported Braking Action

MAX MANUAL	1720	110/-115	55/70	-95/330	50/-45	50/-50	75	120	260
AUTOBRAKE MAX	1750	110/-115	55/75	-95/325	50/-45	50/-50	85	125	270
AUTOBRAKE 3	1870	115/-125	55/75	-100/340	30/-20	55/-55	110	55	170

Medium To Poor Reported Braking Action

MAX MANUAL	1930	150/-145	75/100	-120/425	75/-60	65/-65	95	200	475
AUTOBRAKE MAX	1945	150/-150	75/100	-120/425	80/-65	65/-65	95	200	480
AUTOBRAKE 3	1960	150/-135	75/100	-110/425	75/-45	65/-65	100	200	480

Poor Reported Braking Action

MAX MANUAL	2500	175/-180	90/115	-165/605	220/-140	80/-80	95	450	1250
AUTOBRAKE MAX	2515	180/-180	90/120	-165/605	225/-145	80/-80	95	455	1255
AUTOBRAKE 3	2520	180/-180	90/120	-165/610	225/-140	80/-80	100	455	1260

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Trailing Edge Flaps Up Landing
VREF40 + 40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1545	140/-80	40/55	-60/200	15/-15	40/-40	55	35	60
AUTOBRAKE MAX	1820	105/-90	50/65	-70/225	0/0	50/-50	80	5	10
AUTOBRAKE 2	3060	205/-200	105/135	-135/440	50/-60	95/-95	115	185	185

Good Reported Braking Action

MAX MANUAL	2015	145/-125	75/105	-100/340	40/-35	70/-70	85	140	285
AUTOBRAKE MAX	2030	145/-125	75/105	-95/335	40/-35	70/-70	90	140	290
AUTOBRAKE 2	3060	205/-200	105/140	-135/445	55/-60	95/-95	115	185	185

Good To Medium Reported Braking Action

MAX MANUAL	2170	145/-130	80/105	-105/360	55/-45	70/-70	85	170	355
AUTOBRAKE MAX	2185	145/-130	80/105	-105/355	50/-45	70/-70	90	170	365
AUTOBRAKE 2	3060	205/-200	105/140	-135/445	55/-60	95/-95	115	185	185

Medium Reported Braking Action

MAX MANUAL	2285	150/-135	80/110	-110/380	65/-55	70/-70	85	205	450
AUTOBRAKE MAX	2300	150/-135	80/110	-110/375	65/-55	70/-70	90	210	455
AUTOBRAKE 3	2600	150/-145	85/105	-115/385	30/-25	80/-80	125	60	210

Medium To Poor Reported Braking Action

MAX MANUAL	2675	205/-180	110/145	-135/480	100/-85	90/-90	100	400	1045
AUTOBRAKE MAX	2670	205/-180	110/145	-135/480	105/-90	90/-90	100	400	1045
AUTOBRAKE 3	2705	205/-155	110/145	-125/485	95/-55	95/-90	120	385	1030

Poor Reported Braking Action

MAX MANUAL	3265	235/-215	125/165	-180/655	250/-165	105/-105	100	710	2065
AUTOBRAKE MAX	3260	235/-215	125/165	-180/655	260/-170	105/-105	100	705	2060
AUTOBRAKE 3	3290	230/-210	125/165	-180/660	245/-150	105/-105	120	690	2050

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Reference Brake Energy (Millions of Foot Pounds)

Table 1(a) of 3: Sea Level to 10000 ft Pressure Altitude

		BRAKES ON SPEED (KIAS)																	
		80			100			120			140			160			180		
WEIGHT (1000 KG)	OAT (°C)	PRESSURE ALTITUDE (1000 FT)																	
		0	5	10	0	5	10	0	5	10	0	5	10	0	5	10	0	5	10
90	0	16.6	18.8	21.5	24.6	28.2	32.5	33.9	39.2	45.6	44.2	51.4	60.0	55.3					
	10	17.1	19.5	22.2	25.4	29.1	33.6	35.0	40.5	47.1	45.7	53.2	62.0	57.2					
	15	17.4	19.8	22.6	25.8	29.6	34.1	35.6	41.2	47.8	46.4	54.0	63.0	58.1					
	20	17.7	20.1	22.9	26.2	30.1	34.7	36.1	41.8	48.6	47.2	54.9	64.0	59.0					
	30	18.2	20.6	23.6	26.9	30.9	35.7	37.2	43.0	50.0	48.6	56.5	66.0	60.8					
	40	18.2	20.7	23.7	27.1	31.1	36.0	37.5	43.5	50.8	49.2	57.5	67.3	61.9					
	50	18.2	20.7	23.7	27.2	31.3	36.3	37.8	44.0	51.5	49.9	58.4	68.6	63.0					
80	0	15.1	17.1	19.5	22.3	25.5	29.4	30.6	35.4	41.0	39.9	46.4	54.1	50.0	58.1		60.3		
	10	15.6	17.7	20.1	23.0	26.4	30.3	31.6	36.5	42.4	41.3	47.9	55.9	51.6	60.1		62.3		
	15	15.9	18.0	20.5	23.4	26.8	30.8	32.1	37.1	43.1	41.9	48.7	56.8	52.5	61.0		63.4		
	20	16.1	18.2	20.8	23.8	27.2	31.3	32.7	37.7	43.7	42.6	49.5	57.7	53.3	62.0		64.4		
	30	16.5	18.7	21.4	24.4	28.0	32.2	33.6	38.8	45.0	43.8	50.9	59.4	54.9	63.9		66.3		
	40	16.6	18.8	21.4	24.6	28.2	32.5	33.9	39.2	45.6	44.4	51.7	60.5	55.8	65.1		67.7		
	50	16.6	18.8	21.5	24.7	28.3	32.7	34.1	39.6	46.1	44.9	52.4	61.6	56.7	66.4		69.0		
70	0	13.7	15.5	17.6	20.0	22.9	26.2	27.3	31.4	36.4	35.5	41.1	47.8	44.4	51.7	60.3	53.8		
	10	14.1	16.0	18.2	20.7	23.6	27.1	28.2	32.5	37.6	36.7	42.5	49.4	45.9	53.4	62.3	55.6		
	15	14.3	16.2	18.4	21.0	24.0	27.5	28.7	33.0	38.2	37.2	43.2	50.2	46.6	54.3	63.3	56.5		
	20	14.6	16.5	18.7	21.3	24.4	27.9	29.1	33.5	38.8	37.8	43.8	51.0	47.4	55.1	64.3	57.4		
	30	15.0	16.9	19.2	21.9	25.0	28.7	29.9	34.5	39.9	38.9	45.1	52.5	48.8	56.8	66.3	59.1		
	40	15.0	17.0	19.3	22.0	25.2	28.9	30.2	34.8	40.3	39.3	45.7	53.3	49.5	57.7	67.6	60.2		
	50	15.0	17.0	19.3	22.1	25.3	29.1	30.3	35.1	40.7	39.7	46.2	54.1	50.1	58.7	69.0	61.2		
60	0	12.2	13.8	15.7	17.7	20.2	23.1	24.0	27.5	31.7	31.0	35.8	41.5	38.6	44.8	52.1	46.7	54.4	
	10	12.7	14.3	16.2	18.3	20.9	23.8	24.8	28.4	32.8	32.0	37.0	42.9	39.9	46.3	53.9	48.3	56.2	
	15	12.8	14.5	16.4	18.6	21.2	24.2	25.2	28.9	33.3	32.5	37.5	43.6	40.5	47.0	54.8	49.1	57.1	
	20	13.0	14.7	16.7	18.9	21.5	24.6	25.6	29.3	33.8	33.0	38.1	44.2	41.1	47.7	55.6	49.8	58.0	
	30	13.4	15.1	17.2	19.4	22.1	25.3	26.3	30.2	34.8	34.0	39.2	45.5	42.3	49.1	57.3	51.3	59.7	
	40	13.4	15.2	17.2	19.5	22.2	25.4	26.5	30.4	35.1	34.3	39.7	46.1	42.8	49.8	58.3	52.1	60.8	
	50	13.4	15.2	17.2	19.5	22.3	25.5	26.6	30.6	35.4	34.5	40.0	46.7	43.3	50.5	59.3	52.8	61.9	
50	0	10.8	12.2	13.8	15.5	17.5	20.0	20.7	23.6	27.1	26.5	30.4	35.2	32.7	37.8	44.0	39.4	45.8	53.3
	10	11.2	12.6	14.2	16.0	18.1	20.6	21.4	24.4	28.0	27.3	31.4	36.3	33.8	39.1	45.4	40.7	47.3	55.1
	15	11.4	12.8	14.5	16.2	18.4	21.0	21.7	24.8	28.5	27.8	31.9	36.9	34.4	39.7	46.2	41.4	48.1	56.0
	20	11.5	13.0	14.7	16.5	18.7	21.3	22.0	25.2	28.9	28.2	32.4	37.5	34.9	40.4	46.9	42.0	48.8	56.9
	30	11.9	13.3	15.1	16.9	19.2	21.9	22.7	25.9	29.7	29.0	33.4	38.6	35.9	41.5	48.3	43.3	50.3	58.6
	40	11.9	13.4	15.1	17.0	19.3	22.0	22.8	26.0	29.9	29.2	33.6	39.0	36.2	42.0	48.9	43.8	51.0	59.6
	50	11.9	13.4	15.1	17.0	19.3	22.0	22.8	26.1	30.1	29.4	33.9	39.3	36.5	42.4	49.6	44.3	51.7	60.7
40	0	9.4	10.6	11.9	13.2	14.9	16.9	17.3	19.7	22.5	21.9	25.1	28.8	26.8	30.8	35.7	32.0	37.0	42.9
	10	9.8	10.9	12.3	13.6	15.4	17.5	17.9	20.4	23.3	22.6	25.9	29.8	27.7	31.9	36.8	33.1	38.2	44.4
	15	9.9	11.1	12.5	13.8	15.6	17.7	18.2	20.7	23.6	23.0	26.3	30.2	28.1	32.4	37.4	33.6	38.8	45.1
	20	10.1	11.3	12.7	14.0	15.9	18.0	18.5	21.0	24.0	23.3	26.7	30.7	28.6	32.9	38.0	34.1	39.4	45.8
	30	10.3	11.6	13.1	14.4	16.3	18.5	19.0	21.6	24.7	24.0	27.5	31.6	29.4	33.8	39.1	35.1	40.6	47.1
	40	10.3	11.6	13.1	14.5	16.3	18.6	19.0	21.7	24.8	24.1	27.6	31.8	29.6	34.1	39.5	35.4	41.0	47.8
	50	10.3	11.6	13.1	14.4	16.3	18.6	19.1	21.7	24.9	24.2	27.8	32.0	29.8	34.4	39.9	35.7	41.4	48.4

To correct for wind, enter table with the brakes-on speed minus one-half the headwind or plus 1.5 times the tailwind. If ground speed is used for brakes-on speed, ignore wind and enter table with sea level, 15°C.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule
Reference Brake Energy (Millions of Foot Pounds)
Table 1(b) of 3: 10000 ft to 14500 ft Pressure Altitude

		BRAKES ON SPEED (KIAS)																	
		80			100			120			140			160			180		
WEIGHT	OAT	PRESSURE ALTITUDE (1000 FT)																	
(1000 KG)	(°C)	10	12	14.5	10	12	14.5	10	12	14.5	10	12	14.5	10	12	14.5	10	12	14.5
90	0	21.5	22.7	24.1	32.5	34.4	37.0	45.6	48.4	52.2	60.0								
	10	22.2	23.4	25.0	33.6	35.6	38.2	47.1	50.0	54.0	62.0								
	15	22.6	23.8	25.4	34.1	36.1	38.9	47.8	50.8	54.9	63.0								
	20	22.9	24.1	25.8	34.7	36.7	39.5	48.6	51.6	55.8	64.0								
	30	23.6	24.8	26.5	35.7	37.8	40.6	50.0	53.2	57.4	66.0								
	40	23.7	25.0	26.7	36.0	38.2	41.0	50.8	54.0	58.4	67.3								
	50	23.7	25.1	26.8	36.3	38.5	41.4	51.5	54.8	59.4	68.6								
80	0	19.5	20.5	21.9	29.4	31.1	33.3	41.0	43.5	46.9	54.1	57.5							
	10	20.1	21.2	22.6	30.3	32.1	34.4	42.4	45.0	48.5	55.9	59.4							
	15	20.5	21.5	22.9	30.8	32.6	35.0	43.1	45.7	49.3	56.8	60.4							
	20	20.8	21.9	23.3	31.3	33.1	35.5	43.7	46.4	50.1	57.7	61.4							
	30	21.4	22.5	23.9	32.2	34.1	36.5	45.0	47.8	51.5	59.4	63.2							
	40	21.4	22.6	24.1	32.5	34.4	36.9	45.6	48.4	52.3	60.5	64.4							
	50	21.5	22.7	24.1	32.7	34.6	37.2	46.1	49.1	53.1	61.6	65.7							
70	0	17.6	18.5	19.7	26.2	27.7	29.6	36.4	38.6	41.5	47.8	50.8	54.9	60.3					
	10	18.2	19.1	20.3	27.1	28.6	30.6	37.6	39.8	42.9	49.4	52.5	56.7	62.3					
	15	18.4	19.4	20.6	27.5	29.1	31.1	38.2	40.5	43.6	50.2	53.4	57.6	63.3					
	20	18.7	19.7	21.0	27.9	29.5	31.6	38.8	41.1	44.3	51.0	54.2	58.5	64.3					
	30	19.2	20.2	21.5	28.7	30.3	32.5	39.9	42.3	45.6	52.5	55.8	60.3	66.3					
	40	19.3	20.3	21.6	28.9	30.6	32.8	40.3	42.8	46.1	53.3	56.8	61.4	67.6					
	50	19.3	20.3	21.7	29.1	30.8	33.0	40.7	43.3	46.7	54.1	57.7	62.5	69.0					
60	0	15.7	16.5	17.5	23.1	24.3	26.0	31.7	33.6	36.0	41.5	44.0	47.5	52.1	55.4	59.9			
	10	16.2	17.0	18.0	23.8	25.1	26.9	32.8	34.7	37.3	42.9	45.5	49.1	53.9	57.3	61.9			
	15	16.4	17.3	18.3	24.2	25.5	27.3	33.3	35.3	37.9	43.6	46.2	49.9	54.8	58.2	62.9			
	20	16.7	17.5	18.6	24.6	25.9	27.7	33.8	35.8	38.5	44.2	47.0	50.7	55.6	59.2	63.9			
	30	17.2	18.0	19.1	25.3	26.7	28.5	34.8	36.8	39.6	45.5	48.4	52.1	57.3	60.9	65.9			
	40	17.2	18.1	19.2	25.4	26.8	28.7	35.1	37.2	40.0	46.1	49.0	52.9	58.3	62.1	67.2			
	50	17.2	18.1	19.2	25.5	27	28.8	35.4	37.5	40.4	46.7	49.7	53.7	59.3	63.2	68.5			
50	0	13.8	14.5	15.3	20.0	21.0	22.4	27.1	28.7	30.7	35.2	37.3	40.1	44.0	46.7	50.4	53.3	56.7	
	10	14.2	14.9	15.8	20.6	21.7	23.1	28.0	29.6	31.7	36.3	38.5	41.4	45.4	48.3	52.0	55.1	58.6	
	15	14.5	15.2	16.1	21.0	22.1	23.5	28.5	30.1	32.2	36.9	39.1	42.1	46.2	49.0	52.9	56.0	59.6	
	20	14.7	15.4	16.3	21.3	22.4	23.9	28.9	30.6	32.7	37.5	39.7	42.7	46.9	49.8	53.7	56.9	60.5	
	30	15.1	15.8	16.8	21.9	23.0	24.5	29.7	31.4	33.7	38.6	40.9	44.0	48.3	51.3	55.3	58.6	62.3	
	40	15.1	15.9	16.8	22.0	23.2	24.7	29.9	31.7	34.0	39.0	41.3	44.5	48.9	52.0	56.2	59.6	63.5	
	50	15.1	15.9	16.8	22.0	23.2	24.8	30.1	31.9	34.2	39.3	41.8	45.0	49.6	52.8	57.1	60.7	64.7	
40	0	11.9	12.5	13.2	16.9	17.8	18.9	22.5	23.8	25.4	28.8	30.5	32.7	35.7	37.8	40.7	42.9	45.6	49.2
	10	12.3	12.9	13.7	17.5	18.4	19.5	23.3	24.5	26.2	29.8	31.5	33.8	36.8	39.1	42.0	44.4	47.1	50.8
	15	12.5	13.1	13.9	17.7	18.6	19.8	23.6	24.9	26.6	30.2	32.0	34.3	37.4	39.7	42.7	45.1	47.9	51.6
	20	12.7	13.3	14.1	18.0	18.9	20.1	24.0	25.3	27.1	30.7	32.5	34.8	38.0	40.3	43.4	45.8	48.6	52.4
	30	13.1	13.7	14.5	18.5	19.5	20.7	24.7	26.0	27.8	31.6	33.4	35.8	39.1	41.5	44.6	47.1	50.1	54.0
	40	13.1	13.7	14.5	18.6	19.5	20.8	24.8	26.2	28.0	31.8	33.7	36.1	39.5	41.9	45.2	47.8	50.8	54.9
	50	13.1	13.7	14.5	18.6	19.6	20.8	24.9	26.3	28.1	32.0	33.9	36.4	39.9	42.4	45.7	48.4	51.5	55.7

To correct for wind, enter table with the brakes-on speed minus one-half the headwind or plus 1.5 times the tailwind. If ground speed is used for brakes-on speed, ignore wind and enter table with sea level, 15°C.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Event Adjusted Brake Energy (Millions of Foot Pounds)

Table 2(a) of 3: No Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)					
EVENT		10	20	30	40	50	60
RTO MAX MAN		10.0	20.0	30.0	40.0	50.0	60.0
LANDING	MAX MAN	7.9	16.4	25.5	35.0	44.8	54.8
	MAX AUTO	7.4	15.3	23.7	32.6	41.9	51.5
	AUTOBRAKE 3	7.1	14.4	22.1	30.0	38.3	47.0
	AUTOBRAKE 2	6.6	13.3	20.1	27.1	34.3	41.8
	AUTOBRAKE 1	6.1	12.2	18.3	24.5	30.9	37.6

Table 2(b) of 3: Two Engine Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)					
EVENT		10	20	30	40	50	60
RTO MAX MAN		10.0	20.0	30.0	40.0	50.0	60.0
LANDING	MAX MAN	7.2	15.2	23.7	32.6	41.8	51.0
	MAX AUTO	6.0	12.6	19.8	27.5	35.7	44.4
	AUTOBRAKE 3	4.3	9.0	14.3	20.2	26.5	33.3
	AUTOBRAKE 2	2.4	5.2	8.4	12.0	16.1	20.6
	AUTOBRAKE 1	1.7	3.6	5.8	8.3	11.1	14.3

Table 3 of 3: Cooling Time (Minutes)

	EVENT ADJUSTED BRAKE ENERGY (MILLIONS OF FOOT POUNDS)										
	16.4 & BELOW	17	19	20.9	22.4	23.5	25.1	26.9	28.2	29.9 TO 41	41 & ABOVE
GEAR DOWN INFLIGHT	NO SPECIAL PROCEDURE REQUIRED	1.0	4.0	5.0	5.6	6.0	6.5	7.0	7.3	CAUTION	FUSE PLUG MELT ZONE
GROUND		6.6	16.1	24.2	30	34.3	40	45.8	50		
BRAKE TEMPERATURE INDICATION	UP TO 2.5	2.6	3.0	3.3	3.6	3.8	4.1	4.5	4.7	*5.0 TO 7.1	7.1 & ABOVE

Observe maximum quick turnaround limit. Table shows energy per brake added by a single stop with all brakes operating. Energy is assumed to be equally distributed among the operating brakes. Total energy is the sum of residual energy plus energy added.

Add 1.0 million foot pounds for each taxi mile.

When in caution zone, wheel fuse plugs may melt. Delay takeoff and inspect after one hour. If overheat occurs after takeoff, extend gear soon for at least 7 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not approach gear or attempt taxi for one hour. Tire, wheel and brake replacement may be required. If overheat occurs after takeoff, extend gear soon for at least 12 minutes.

Brake temperature indication on Multifunction Display may be used 10 to 15 minutes after airplane has come to a complete stop, or in flight with gear retracted, to determine recommended cooling schedule.

***For airplanes with TBMS (combined Tire Pressure and Brake Temperature Monitoring System), the beginning of the caution range can vary from 5.0 to 6.2 depending on wheel temperature.**

Intentionally
Blank

ENGINE INOP

Initial Max Continuous %N1

Based on .79M, A/C high and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT)								
	25	27	29	31	33	35	37	39	41
20	88.8	88.5	88.1	88.7	88.0	88.1	88.3	87.7	87.1
15	89.9	89.5	89.1	89.6	89.4	88.4	87.6	87.0	86.4
10	91.0	90.5	90.1	90.5	90.3	89.9	88.7	88.2	87.6
5	91.4	91.4	91.0	91.3	91.2	90.8	90.1	89.6	89.0
0	90.7	91.6	91.8	92.2	92.0	91.6	90.9	90.2	89.4
-5	89.8	90.7	91.7	92.8	92.6	92.3	91.5	90.8	89.9
-10	88.8	89.7	90.8	92.4	93.3	93.1	92.3	91.5	90.6
-15	88.0	88.9	89.9	91.6	92.9	93.9	93.1	92.4	91.5
-20	87.2	88.1	89.1	90.7	92.0	93.3	93.2	92.6	91.7
-25	86.4	87.3	88.3	89.9	91.2	92.3	92.3	91.6	90.7
-30	85.6	86.4	87.4	89.0	90.3	91.4	91.4	90.7	89.8
-35	84.7	85.6	86.5	88.1	89.4	90.5	90.4	89.8	88.9
-40	83.9	84.7	85.7	87.3	88.5	89.6	89.5	88.8	88.0

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	25	27	29	31	33	35	37	39	41
ENGINE ANTI-ICE	-0.9	-1.0	-1.1	-1.2	-1.5	-1.8	-2.0	-2.1	-2.1
ENGINE & WING ANTI-ICE	-3.3	-3.5	-3.8	-4.1	-4.9	-6.1	-6.3	-6.4	-6.4

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

37000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
160	.51	87.9	88.8	89.8	90.8	91.8	91.9	91.9	91.9	91.5	90.5	89.5	89.9
200	.63	87.6	88.6	89.6	90.6	91.6	92.5	92.8	92.8	92.4	91.6	90.6	89.7
240	.74	87.1	88.1	89.0	90.0	91.0	91.9	92.9	93.5	93.1	92.1	91.3	90.7
280	.86	85.3	86.2	87.2	88.2	89.1	90.0	91.0	91.9	92.8	92.6	91.8	91.2

35000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
160	.49	87.9	88.9	89.9	90.9	91.8	92.1	92.1	92.1	92.1	91.4	90.2	90.0
200	.60	87.1	88.1	89.0	90.0	90.9	91.9	92.3	92.3	92.3	92.3	91.4	90.4
240	.71	87.1	88.1	89.1	90.0	90.9	91.9	92.8	93.5	93.4	92.8	92.0	91.3
280	.82	86.0	87.0	87.9	88.9	89.8	90.7	91.6	92.5	93.4	93.2	92.4	91.7

33000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
160	.47	88.9	89.9	90.8	91.8	92.6	92.6	92.6	92.2	91.6	90.8	89.5	89.9
200	.58	88.5	89.4	90.4	91.3	92.2	93.1	93.1	92.6	92.1	91.6	90.9	89.5
240	.68	87.8	88.8	89.7	90.6	91.5	92.4	93.3	93.4	92.8	92.2	91.6	90.6
280	.79	86.7	87.6	88.5	89.4	90.3	91.2	92.1	92.9	93.3	92.6	92.0	91.2
320	.89	85.3	86.3	87.2	88.0	88.9	89.8	90.6	91.5	92.3	93.3	93.1	92.3

31000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
160	.45	88.7	89.7	90.6	91.5	92.4	93	92.9	92.5	91.7	90.9	90.0	89.0
200	.55	88.6	89.5	90.4	91.3	92.2	93.1	93.6	93.2	92.3	91.6	91.0	89.8
240	.66	87.7	88.6	89.5	90.4	91.3	92.2	93.1	93.7	93.1	92.2	91.6	90.7
280	.76	86.1	87.0	87.9	88.8	89.7	90.5	91.4	92.2	93.1	92.7	92.1	91.2
320	.85	84.1	85.0	85.9	86.8	87.6	88.5	89.3	90.1	91	91.9	92.4	91.7

29000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
160	.43	89.0	89.9	90.8	91.8	92.7	92.9	92.3	91.3	90.5	89.8	88.2	87.9
200	.53	88.7	89.6	90.5	91.4	92.3	93.2	93.1	92.2	91.3	90.5	89.4	87.8
240	.63	88.0	88.9	89.8	90.7	91.6	92.5	93.3	92.9	92.0	91.1	90.1	89.0
280	.73	86.1	87.0	87.9	88.8	89.6	90.5	91.4	92.2	92.4	91.6	90.7	89.7
320	.82	84.0	84.9	85.8	86.6	87.5	88.3	89.2	90.0	90.9	91.8	91.1	90.3
360	.91	83.5	84.4	85.3	86.2	87.0	87.9	88.7	89.5	90.4	91.3	92.0	92.0

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	37	35	33	31	29
ENGINE ANTI-ICE	-2.0	-1.8	-1.5	-1.2	-1.1
ENGINE & WING ANTI-ICE	-6.1	-6.0	-4.8	-4.0	-3.7

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

27000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
160	.41	89.0	90.0	90.9	91.8	92.7	93.5	93.1	91.8	90.9	90.3	89.1	87.1
200	.51	88.2	89.2	90.1	91.0	91.8	92.7	93.3	92.5	91.7	91.0	89.8	88.6
240	.6	87.4	88.3	89.2	90.1	91.0	91.9	92.7	93.4	92.4	91.6	90.6	89.5
280	.7	85.7	86.6	87.5	88.4	89.2	90.1	90.9	91.7	92.7	92.1	91.1	90.0
320	.79	83.8	84.7	85.5	86.4	87.2	88.1	88.9	89.7	90.7	91.6	91.4	90.5
360	.88	82.6	83.5	84.4	85.2	86.1	86.9	87.7	88.5	89.5	90.4	91.1	91.6

25000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
160	.39	90.1	91.0	91.9	92.8	93.7	93.7	92.4	91.4	90.7	89.7	88.1	86.9
200	.49	89.0	89.9	90.8	91.6	92.5	93.4	93.1	92.1	91.3	90.3	89.1	87.5
240	.58	87.7	88.6	89.4	90.3	91.2	92.0	92.9	92.8	91.9	90.9	89.8	88.6
280	.67	86.2	87.0	87.9	88.8	89.6	90.5	91.3	92.2	92.4	91.5	90.4	89.2
320	.76	84.4	85.3	86.1	87.0	87.8	88.6	89.4	90.4	91.3	91.8	90.8	89.7
360	.85	82.6	83.4	84.3	85.1	85.9	86.7	87.5	88.4	89.3	90.0	90.8	90.2

24000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
160	.38	89.4	90.3	91.3	92.2	93.0	93.9	92.7	91.7	90.9	89.9	88.7	86.9
200	.48	88.9	89.8	90.7	91.6	92.5	93.4	93.8	92.8	91.8	90.9	89.8	88.6
240	.57	88.1	89.0	89.9	90.8	91.7	92.5	93.4	93.7	92.8	91.8	90.8	89.7
280	.66	86.7	87.6	88.5	89.4	90.2	91.1	91.9	92.7	93.3	92.4	91.4	90.3
320	.75	85.0	85.9	86.8	87.7	88.5	89.3	90.2	91.0	91.8	92.6	91.8	90.8
360	.83	83.2	84.1	85.0	85.8	86.6	87.5	88.3	89.1	89.9	90.6	91.4	91.3

22000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
160	.37	88.2	89.1	89.9	90.8	91.7	92.0	91.2	90.3	89.4	88.3	87.2	86.5
200	.46	87.9	88.8	89.7	90.6	91.4	92.3	92.2	91.4	90.4	89.3	88.3	87.1
240	.55	88.9	89.8	90.7	91.6	92.4	93.3	94.1	93.8	92.9	92.0	91.0	89.9
280	.63	87.7	88.6	89.5	90.4	91.2	92.1	92.9	93.7	93.5	92.5	91.5	90.5
320	.72	86.2	87.1	87.9	88.8	89.6	90.5	91.3	92.1	92.9	93.0	92.1	91.1
360	.80	84.5	85.4	86.2	87.1	87.9	88.7	89.5	90.3	91.1	91.9	92.4	91.5

20000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
160	.35	86.4	87.3	88.2	89.0	89.9	90.7	90.7	89.9	88.9	87.8	86.7	85.9
200	.44	86.0	86.9	87.8	88.6	89.5	90.3	91.1	90.6	89.5	88.4	87.3	86.2
240	.53	88.7	89.6	90.5	91.4	92.3	93.1	94.0	94.7	94.0	93.0	92.0	91.0
280	.61	88.0	88.9	89.8	90.7	91.6	92.4	93.3	94.1	94.8	93.8	92.9	92.0
320	.69	86.6	87.5	88.3	89.2	90.1	90.9	91.7	92.6	93.4	94.2	93.5	92.6
360	.77	85.1	85.9	86.8	87.6	88.4	89.3	90.1	90.9	91.7	92.5	93.3	92.9

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	27	25	24	22	20
ENGINE ANTI-ICE	-0.9	-0.9	-0.8	-0.9	-0.8
ENGINE & WING ANTI-ICE	-3.4	-3.3	-3.3	-3.3	-3.2

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

18000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
160	.34	86.6	87.4	88.3	89.1	89.9	90.7	90.2	89.2	88.1	87.0	85.9	85.1
200	.42	85.9	86.8	87.6	88.4	89.2	90.0	90.5	89.9	88.8	87.6	86.5	85.6
240	.51	88.6	89.4	90.3	91.1	92.0	92.8	93.6	93.8	93.1	92.1	90.9	90.0
280	.59	89.1	90.0	90.8	91.7	92.5	93.3	94.2	95.0	94.9	94.1	93.2	92.4
320	.67	87.8	88.7	89.5	90.4	91.2	92.0	92.8	93.6	94.4	94.6	93.8	92.9
360	.75	86.5	87.3	88.1	88.9	89.8	90.6	91.4	92.2	92.9	93.7	94.1	93.3

16000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
160	.33	85.9	86.8	87.6	88.4	89.2	90.0	90.5	89.6	88.5	87.3	86.2	85.2
200	.41	85.3	86.1	86.9	87.7	88.5	89.3	90.1	90.0	89.1	87.9	86.8	85.8
240	.49	86.3	87.1	87.9	88.7	89.5	90.3	91.2	92.0	91.9	90.9	89.8	88.7
280	.57	89.0	89.9	90.7	91.6	92.4	93.2	94.0	94.9	95.7	94.9	94.1	93.3
320	.64	87.8	88.7	89.5	90.4	91.2	92.0	92.8	93.6	94.4	95.2	94.7	93.8
360	.72	86.6	87.4	88.3	89.1	89.9	90.7	91.5	92.3	93.1	93.9	94.7	94.2

14000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
160	.31	86.4	87.3	88.1	88.9	89.7	90.5	90.5	89.6	88.5	87.4	86.4	85.3
200	.39	85.8	86.6	87.4	88.2	89.0	89.7	90.5	90.1	89.1	88.0	86.9	85.9
240	.47	85.4	86.2	87.1	87.8	88.6	89.4	90.2	90.9	90.9	89.8	88.8	87.7
280	.54	89.1	90.0	90.8	91.6	92.5	93.3	94.1	94.9	95.2	94.4	93.5	92.6
320	.62	88.3	89.2	90.0	90.8	91.7	92.5	93.3	94.0	94.8	95.0	94.3	93.4
360	.69	86.6	87.5	88.3	89.1	89.9	90.7	91.5	92.3	93.0	93.8	94.2	93.7

12000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	35
160	.30	87.1	87.9	88.7	89.6	90.4	91.2	91.2	90.4	89.4	88.4	87.4	86.4
200	.38	86.3	87.1	88.0	88.8	89.6	90.4	91.0	90.9	89.9	89.0	88.0	87.0
240	.45	85.5	86.3	87.1	87.9	88.7	89.5	90.3	90.7	90.3	89.5	88.6	87.6
280	.52	88.5	89.4	90.2	91.1	91.9	92.7	93.5	94.3	94.3	93.7	92.8	91.9
320	.60	88.3	89.1	89.9	90.8	91.6	92.4	93.2	94.0	94.8	94.3	93.4	92.6
360	.67	86.1	87.0	87.8	88.6	89.4	90.2	91.0	91.7	92.5	93.3	93.0	92.5

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	18	16	14	12
ENGINE ANTI-ICE	-0.9	-0.7	-0.7	-0.7
ENGINE & WING ANTI-ICE	-3.2	-3.0	-2.9	-2.7

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

10000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	35
160	.29	87.0	87.8	88.7	89.5	90.3	91.1	91.9	91.9	91.3	90.4	89.5	88.6
200	.36	86.3	87.2	88.0	88.8	89.6	90.5	91.3	91.7	91.5	90.9	90.0	89.1
240	.43	85.6	86.4	87.3	88.1	88.9	89.7	90.5	91.3	91.4	91.3	90.4	89.4
280	.51	88.2	89.0	89.9	90.7	91.6	92.4	93.2	94.0	94.7	93.9	93.0	92.1
320	.58	87.3	88.2	89.0	89.8	90.7	91.5	92.3	93.1	93.9	94.3	93.4	92.5
360	.65	84.5	85.3	86.1	86.9	87.7	88.5	89.3	90.1	90.9	91.6	92.1	92.1

5000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-10	-5	0	5	10	15	20	25	30	35	40	45
160	.26	86.8	87.7	88.5	89.3	90.1	90.9	91.6	91.3	90.4	89.5	88.6	87.6
200	.33	86.4	87.2	88.1	88.9	89.7	90.5	91.3	91.5	90.9	89.9	88.9	88.0
240	.40	85.9	86.7	87.6	88.4	89.2	90.0	90.8	91.4	91.3	90.4	89.5	88.5
280	.46	85.7	86.5	87.3	88.2	89.0	89.8	90.6	91.4	91.6	91.1	90.2	89.3
320	.53	85.5	86.3	87.1	88.0	88.8	89.6	90.4	91.1	91.9	91.8	91.3	90.5
360	.59	81.5	82.3	83.1	83.8	84.6	85.4	86.1	86.9	87.6	88.4	88.4	88.4

3000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-5	0	5	10	15	20	25	30	35	40	45	50
160	.26	86.8	87.7	88.5	89.3	90.1	90.9	91.2	90.5	89.6	88.6	87.6	86.6
200	.32	86.5	87.3	88.1	88.9	89.7	90.5	91.3	90.8	89.9	89.0	88.0	87.0
240	.38	86.1	86.9	87.7	88.5	89.2	90.0	90.8	91.1	90.4	89.5	88.5	87.5
280	.45	85.4	86.2	87.0	87.8	88.6	89.4	90.2	91.0	90.7	89.9	89.0	88.1
320	.51	84.7	85.5	86.3	87.1	87.9	88.6	89.4	90.2	90.9	90.8	90.0	89.3
360	.57	80.5	81.3	82.0	82.8	83.5	84.2	85.0	85.7	86.4	86.9	86.9	86.9

1000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-5	0	5	10	15	20	25	30	35	40	45	50
160	.25	85.9	86.7	87.5	88.3	89.1	89.9	90.7	90.4	89.6	88.7	87.7	86.7
200	.31	85.5	86.3	87.1	87.9	88.7	89.5	90.3	90.7	89.9	89.0	88.0	87.0
240	.37	85.2	86.0	86.8	87.6	88.4	89.1	89.9	90.7	90.3	89.4	88.5	87.5
280	.43	84.6	85.4	86.2	87.0	87.8	88.5	89.3	90.1	90.6	89.9	89.0	88.1
320	.49	82.6	83.4	84.2	84.9	85.7	86.5	87.2	88.0	88.7	89.0	88.9	88.6
360	.55	78.8	79.6	80.3	81.0	81.8	82.5	83.2	83.9	84.6	85.3	85.5	85.5

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	10	5	3	1
ENGINE ANTI-ICE	-0.6	0.0	0.0	0.0
ENGINE & WING ANTI-ICE	-2.5	0.0	0.0	0.0

ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

100 ft/min residual rate of climb

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF PRESSURE ALTITUDE		
START DRIFTDOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
85	81	253	16800	14200	12300
80	77	246	18600	16600	13400
75	72	239	20300	19000	14800
70	67	231	21900	20800	19000
65	63	223	23700	22600	21300
60	58	215	25500	24500	23400
55	53	206	27600	26700	25600
50	48	197	29900	29000	28200
45	43	188	32200	31700	31200
40	38	178	34600	34200	33800

Includes APU fuel burn.

ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown/LRC Cruise Range Capability

Table 1 of 2: Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
142	131	121	113	106	100	94	89	84	80	77
284	262	243	226	212	200	188	178	169	161	154
425	392	364	340	318	300	283	268	254	242	231
567	523	485	453	425	400	377	357	339	323	308
707	653	606	566	531	500	472	447	425	404	386
848	783	727	679	637	600	566	537	510	486	464
988	913	848	792	743	700	661	626	595	567	541
1128	1042	969	905	849	800	755	716	681	648	619
1268	1172	1089	1018	955	900	850	806	766	730	697
1407	1301	1210	1131	1061	1000	945	896	851	811	775
1547	1431	1330	1243	1167	1100	1039	985	937	893	853
1686	1560	1451	1356	1273	1200	1134	1075	1022	974	931
1826	1689	1571	1469	1379	1300	1229	1165	1108	1056	1009
1965	1818	1692	1582	1485	1400	1323	1255	1193	1137	1087
2105	1948	1812	1694	1591	1500	1418	1345	1279	1219	1164
2245	2077	1933	1807	1697	1600	1513	1435	1364	1300	1242
2385	2207	2053	1920	1803	1700	1607	1524	1450	1382	1320
2525	2336	2174	2033	1909	1800	1702	1614	1535	1463	1398

Table 2 of 2: Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 KG)										TIME (HR:MIN)
	WEIGHT AT START OF DRIFTDOWN (1000 KG)										
	40	45	50	55	60	65	70	75	80	85	
100	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0:18
200	0.7	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	0:36
300	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.6	1.7	1.8	0:53
400	1.4	1.5	1.7	1.8	1.9	2.0	2.2	2.3	2.4	2.6	1:11
500	1.8	1.9	2.1	2.3	2.4	2.6	2.8	2.9	3.1	3.3	1:28
600	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.8	4.0	1:45
700	2.5	2.7	2.9	3.2	3.4	3.6	3.9	4.1	4.4	4.7	2:03
800	2.8	3.1	3.4	3.6	3.9	4.2	4.5	4.7	5.0	5.4	2:20
900	3.2	3.5	3.8	4.1	4.4	4.7	5.0	5.3	5.7	6.0	2:37
1000	3.5	3.9	4.2	4.5	4.9	5.2	5.6	5.9	6.3	6.7	2:54
1100	3.8	4.2	4.6	5.0	5.3	5.7	6.1	6.5	6.9	7.4	3:11
1200	4.2	4.6	5.0	5.4	5.8	6.3	6.7	7.1	7.6	8.0	3:28
1300	4.5	5.0	5.4	5.9	6.3	6.8	7.2	7.7	8.2	8.7	3:45
1400	4.8	5.3	5.8	6.3	6.8	7.3	7.8	8.3	8.8	9.3	4:02
1500	5.2	5.7	6.2	6.7	7.3	7.8	8.3	8.9	9.4	10.0	4:19
1600	5.5	6.1	6.6	7.2	7.7	8.3	8.9	9.4	10.0	10.6	4:36
1700	5.8	6.4	7.0	7.6	8.2	8.8	9.4	10.0	10.6	11.3	4:53
1800	6.2	6.8	7.4	8.0	8.7	9.3	10.0	10.6	11.3	11.9	5:10

Includes APU fuel burn.
Driftdown at optimum driftdown speed and cruise at Long Range Cruise speed.

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability

100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
85	14700	11800	9100
80	16400	14500	11700
75	18000	16300	14600
70	19600	18000	16500
65	21300	19800	18300
60	23000	21600	20300
55	24900	23400	22200
50	27500	25700	24200
45	30200	28600	27100
40	32700	31800	30700

With engine anti-ice on, decrease altitude capability by 1500 ft.
With engine and wing anti-ice on, decrease altitude capability by 6500 ft.

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)									
		10	15	17	19	21	23	25	27	29	31
85	%N1	87.8	91.7	93.4							
	MACH	.545	.587	.599							
	KIAS	302	297	292							
	FF/ENG	2674	2647	2625							
80	%N1	86.1	90.3	91.8	93.7						
	MACH	.529	.577	.590	.602						
	KIAS	293	292	287	282						
	FF/ENG	2512	2508	2487	2471						
75	%N1	84.3	88.6	90.2	91.7						
	MACH	.513	.562	.580	.593						
	KIAS	284	284	282	277						
	FF/ENG	2352	2357	2348	2328						
70	%N1	82.4	86.7	88.4	90.1	91.7					
	MACH	.496	.545	.565	.582	.595					
	KIAS	275	275	275	272	267					
	FF/ENG	2193	2202	2200	2188	2169					
65	%N1	80.2	84.6	86.4	88.2	89.8	91.6				
	MACH	.479	.527	.547	.567	.584	.596				
	KIAS	265	266	266	265	262	257				
	FF/ENG	2034	2041	2046	2043	2031	2012				
60	%N1	77.9	82.4	84.2	86.0	87.8	89.4				
	MACH	.462	.507	.527	.548	.568	.585				
	KIAS	255	255	256	256	255	252				
	FF/ENG	1881	1883	1886	1890	1886	1875				
55	%N1	75.4	79.9	81.8	83.6	85.4	87.2	88.9			
	MACH	.444	.486	.505	.526	.547	.567	.585			
	KIAS	245	245	245	245	245	244	242			
	FF/ENG	1734	1726	1728	1730	1733	1729	1720			
50	%N1	72.8	77.2	79.1	81.0	82.8	84.7	86.5	88.3	90.4	
	MACH	.425	.465	.483	.502	.523	.544	.565	.584	.597	
	KIAS	235	234	233	234	234	234	233	231	227	
	FF/ENG	1590	1574	1572	1573	1574	1575	1572	1568	1559	
45	%N1	70.0	74.3	76.1	78.0	79.9	81.8	83.7	85.6	87.3	89.4
	MACH	.406	.443	.460	.478	.497	.518	.540	.561	.581	.595
	KIAS	224	223	222	222	222	222	222	222	220	216
	FF/ENG	1452	1429	1423	1418	1418	1416	1418	1419	1417	1408
40	%N1	67.0	71.1	72.9	74.8	76.6	78.5	80.5	82.4	84.3	86.2
	MACH	.387	.421	.436	.453	.470	.489	.510	.532	.555	.576
	KIAS	213	211	210	210	210	209	210	210	210	209
	FF/ENG	1328	1286	1281	1271	1265	1262	1260	1262	1265	1264

Includes APU fuel burn.

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
300	273	249	230	214	200	190	180	172	164	157
605	550	502	463	430	400	380	361	344	328	314
911	828	755	696	645	600	569	540	514	491	470
1219	1107	1010	929	861	800	759	721	686	655	627
1529	1388	1264	1162	1076	1000	948	900	857	818	783
1840	1668	1519	1396	1292	1200	1137	1080	1028	981	939
2153	1951	1775	1630	1508	1400	1327	1259	1198	1143	1094
2468	2235	2032	1865	1724	1600	1516	1439	1369	1306	1250
2785	2520	2289	2100	1940	1800	1705	1618	1540	1469	1406
3104	2806	2547	2335	2157	2000	1895	1798	1710	1631	1561

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		26	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	1.2	0:43	1.1	0:41	1.0	0:39	0.9	0:38	0.8	0:37
400	2.4	1:25	2.3	1:20	2.1	1:16	1.9	1:12	1.8	1:10
600	3.7	2:06	3.4	1:59	3.2	1:53	3.0	1:47	2.8	1:44
800	4.9	2:48	4.6	2:39	4.3	2:30	4.0	2:22	3.8	2:17
1000	6.2	3:31	5.8	3:19	5.4	3:07	5.0	2:57	4.8	2:51
1200	7.4	4:14	6.9	4:00	6.5	3:45	6.1	3:32	5.7	3:25
1400	8.6	4:57	8.0	4:40	7.5	4:23	7.1	4:08	6.7	3:59
1600	9.8	5:41	9.2	5:22	8.6	5:02	8.1	4:44	7.6	4:33
1800	11.0	6:25	10.3	6:03	9.6	5:41	9.1	5:20	8.6	5:08
2000	12.1	7:10	11.4	6:45	10.7	6:20	10.0	5:57	9.5	5:42

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	40	50	60	70	80
1	-0.1	-0.1	0.0	0.1	0.3
2	-0.3	-0.1	0.0	0.3	0.7
3	-0.4	-0.2	0.0	0.5	1.1
4	-0.6	-0.3	0.0	0.6	1.5
5	-0.7	-0.4	0.0	0.8	1.8
6	-0.9	-0.5	0.0	0.9	2.2
7	-1.0	-0.5	0.0	1.0	2.5
8	-1.2	-0.6	0.0	1.2	2.8
9	-1.3	-0.7	0.0	1.3	3.1
10	-1.5	-0.8	0.0	1.4	3.3
11	-1.6	-0.8	0.0	1.5	3.6
12	-1.8	-0.9	0.0	1.6	3.8
13	-1.9	-1.0	0.0	1.7	4.0
14	-2.1	-1.1	0.0	1.8	4.2

Includes APU fuel burn.

ENGINE INOP

MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)							
		1500	5000	10000	15000	20000	25000	30000	35000
85	%N1	75.8	79.2	84.0	88.9				
	KIAS	244	244	246	247				
	FF/ENG	2360	2370	2400	2450				
80	%N1	73.9	77.2	82.2	86.9	93.2			
	KIAS	237	237	238	239	242			
	FF/ENG	2230	2230	2250	2280	2390			
75	%N1	71.9	75.1	80.2	84.9	90.3			
	KIAS	229	229	230	232	233			
	FF/ENG	2100	2080	2100	2130	2190			
70	%N1	69.8	73.0	78.0	82.8	88.0			
	KIAS	220	222	222	224	225			
	FF/ENG	1970	1950	1960	1970	2010			
65	%N1	67.7	70.7	75.6	80.6	85.6			
	KIAS	211	214	214	215	216			
	FF/ENG	1830	1820	1810	1830	1850			
60	%N1	65.4	68.3	73.1	78.2	83.1	88.7		
	KIAS	204	204	206	206	208	209		
	FF/ENG	1690	1690	1670	1680	1700	1740		
55	%N1	63.0	65.9	70.4	75.5	80.6	85.7		
	KIAS	198	198	198	198	199	200		
	FF/ENG	1570	1550	1540	1540	1550	1570		
50	%N1	60.5	63.3	67.7	72.5	77.7	82.7	89.2	
	KIAS	191	191	191	191	191	191	192	
	FF/ENG	1450	1430	1420	1400	1410	1410	1470	
45	%N1	57.8	60.5	64.9	69.6	74.7	79.7	85.0	
	KIAS	185	185	185	185	185	185	185	
	FF/ENG	1330	1320	1300	1280	1270	1270	1290	
40	%N1	55.0	57.5	61.9	66.4	71.3	76.6	81.6	88.4
	KIAS	178	178	178	178	178	178	178	178
	FF/ENG	1220	1210	1190	1170	1160	1140	1150	1200

This table includes 5% additional fuel for holding in a racetrack pattern.
Includes APU fuel burn.

ENGINE INOP

ADVISORY INFORMATION

Gear Down Landing Rate of Climb Available

Flaps 15

TAT (°C)	RATE OF CLIMB (FT/MIN)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
54	-80	-150							
52	-60	-120							
50	-30	-100	-230						
48	0	-70	-200						
46	30	-40	-160	-310					
44	60	-10	-130	-270					
42	90	20	-100	-230	-390				
40	120	50	-70	-200	-350				
38	150	80	-40	-170	-300	-480			
36	160	110	-10	-140	-260	-460			
34	160	140	10	-110	-230	-440	-570		
32	160	150	30	-90	-210	-420	-550		
30	160	150	50	-70	-190	-390	-530	-690	
20	160	150	50	-50	-150	-260	-410	-580	-770
10	170	150	50	-50	-150	-250	-340	-470	-650
0	160	160	50	-60	-160	-260	-350	-470	-620
-20	170	160	50	-60	-160	-260	-360	-480	-640
-40	170	160	50	-60	-170	-280	-380	-500	-660
-50	170	160	50	-60	-170	-280	-380	-520	-680
-54	170	160	50	-70	-180	-280	-390	-520	-680

Rate of climb capability shown is valid for 65000 kg, gear down at VREF15+5.
Decrease rate of climb 100 ft/min per 5000 kg greater than 65000 kg.
Increase rate of climb 150 ft/min per 5000 kg less than 65000 kg.

ENGINE INOP

ADVISORY INFORMATION

Gear Down Landing Rate of Climb Available

Flaps 30

TAT (°C)	RATE OF CLIMB (FT/MIN)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
54	-340	-410							
52	-320	-390							
50	-290	-360	-500						
48	-260	-340	-470						
46	-230	-310	-440	-590					
44	-210	-280	-410	-550					
42	-180	-260	-380	-510	-670				
40	-150	-230	-350	-480	-630				
38	-120	-200	-320	-450	-590	-770			
36	-110	-170	-300	-420	-550	-750			
34	-110	-140	-270	-400	-520	-730	-860		
32	-110	-130	-250	-370	-500	-700	-840		
30	-110	-130	-240	-360	-480	-680	-820	-980	
20	-120	-130	-240	-340	-440	-560	-710	-880	-1080
10	-120	-140	-240	-350	-450	-550	-650	-770	-970
0	-130	-140	-250	-360	-460	-560	-660	-780	-940
-20	-130	-150	-260	-370	-480	-580	-680	-810	-970
-40	-140	-160	-270	-390	-500	-610	-710	-840	-1010
-50	-150	-160	-280	-400	-510	-620	-720	-860	-1030
-54	-150	-170	-280	-400	-520	-630	-730	-870	-1040

Rate of climb capability shown is valid for 65000 kg, gear down at VREF30+5.
Decrease rate of climb 100 ft/min per 5000 kg greater than 65000 kg.
Increase rate of climb 160 ft/min per 5000 kg less than 65000 kg.

ALTERNATE MODE EEC

Alternate Mode EEC Limit Weight

PERFORMANCE LIMIT	NORMAL MODE PERFORMANCE LIMIT WEIGHT (1000 KG)											
	40	45	50	55	60	65	70	75	80	85	90	95
FIELD	39.8	44.8	49.8	54.8	59.8	64.8	69.8	74.9	79.9	84.9	89.9	94.9
CLIMB	39.9	44.9	49.9	54.9	59.9	64.9	69.9	75.0	80.0	85.0	90.0	95.0
OBSTACLE	39.6	44.6	49.6	54.7	59.7	64.7	69.8	74.8	79.8	84.9	89.9	94.9
BRAKE ENERGY	39.1	44.0	49.0	54.0	59.0	64.0	69.0	74.0	79.0	84.0	89.0	94.0

No adjustments to the takeoff speeds for the reduced weight are necessary.

ALTERNATE MODE EEC

Alternate Mode EEC Max Takeoff %N1

Based on engine bleeds for packs on and anti-ice off

AIRPORT	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
OAT (°C)	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	85.6	86.1	86.6	86.7	86.2	85.7	85.2	84.8	84.3	83.9	83.5	83.0	82.5	81.6	80.6	79.5	78.6	78.2
55	86.9	87.3	87.7	87.8	87.4	86.9	86.4	85.9	85.5	85.1	84.6	84.2	83.7	82.7	81.8	80.7	79.8	79.4
50	88.0	88.6	89.2	88.8	88.4	88.0	87.5	87.1	86.6	86.2	85.8	85.3	84.8	83.9	83.0	81.9	81.0	80.6
45	88.9	89.5	90.0	89.9	89.5	88.9	88.6	88.2	87.7	87.3	86.9	86.4	86.0	85.0	84.1	83.0	82.2	81.7
40	89.9	90.4	91.0	90.9	90.9	90.6	89.9	89.1	88.7	88.3	88.0	87.5	87.0	86.1	85.2	84.1	83.3	82.8
35	90.7	91.3	91.9	91.9	91.8	91.7	91.6	91.3	90.7	89.7	88.9	88.5	88.1	87.2	86.3	85.3	84.4	84.0
30	90.2	91.5	92.8	92.6	92.6	92.6	92.5	92.4	92.4	92.2	89.8	89.5	89.1	88.2	87.4	86.4	85.6	85.2
25	89.4	90.7	92.0	92.3	92.7	92.8	92.9	93.2	93.0	93.0	90.8	90.4	90.0	89.2	88.4	87.6	86.7	86.3
20	88.6	89.9	91.2	91.5	91.8	92.1	92.5	92.8	93.0	93.1	91.7	91.3	91.0	90.2	89.5	88.7	87.9	87.5
15	87.8	89.1	90.4	90.7	91.0	91.3	91.6	91.9	92.3	92.6	92.7	92.4	92.0	91.2	90.5	89.8	89.0	88.7
10	87.0	88.3	89.6	89.9	90.2	90.5	90.8	91.1	91.5	91.8	92.2	92.6	93.0	92.2	91.6	90.9	90.2	89.9
5	86.2	87.5	88.8	89.1	89.4	89.7	90.0	90.3	90.7	91.0	91.4	91.8	92.2	92.2	92.2	92.0	91.4	91.1
0	85.4	86.7	87.9	88.3	88.6	88.9	89.2	89.5	89.8	90.2	90.6	91.0	91.4	91.4	91.5	91.5	91.5	91.6
-5	84.6	85.8	87.1	87.4	87.8	88.0	88.3	88.7	89.0	89.4	89.8	90.2	90.5	90.6	90.7	90.7	90.7	90.8
-10	83.8	85.0	86.3	86.6	86.9	87.2	87.5	87.8	88.1	88.5	88.9	89.3	89.7	89.8	89.8	89.9	89.9	89.9
-15	83.0	84.2	85.5	85.8	86.1	86.3	86.6	86.9	87.3	87.7	88.1	88.5	88.9	89.0	89.0	89.1	89.1	89.1
-20	82.2	83.4	84.6	84.9	85.2	85.5	85.7	86.1	86.4	86.8	87.3	87.7	88.1	88.1	88.2	88.2	88.3	88.3
-25	81.4	82.6	83.8	84.1	84.4	84.7	84.9	85.2	85.6	86.0	86.4	86.8	87.2	87.3	87.4	87.4	87.4	87.5
-30	80.5	81.8	83.0	83.3	83.6	83.8	84.1	84.4	84.7	85.1	85.5	86.0	86.4	86.5	86.5	86.6	86.6	86.6
-35	79.7	80.9	82.1	82.4	82.7	83.0	83.2	83.5	83.9	84.3	84.7	85.1	85.5	85.6	85.6	85.7	85.8	85.8
-40	78.9	80.1	81.2	81.6	81.8	82.1	82.4	82.7	83.0	83.4	83.8	84.2	84.6	84.7	84.7	84.8	84.9	84.9
-45	78.0	79.2	80.4	80.7	81.0	81.2	81.5	81.8	82.1	82.5	82.9	83.3	83.7	83.8	83.8	83.9	84.0	84.0
-50	77.2	78.3	79.5	79.8	80.1	80.3	80.6	80.9	81.3	81.6	82.0	82.4	82.7	82.8	82.9	83.0	83.1	83.2

%N1 Adjustments for Engine Bleeds

BLEED	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
CONFIGURATION	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.2	1.4	1.6	1.7	1.8
ENGINE ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6

ALTERNATE MODE EEC

Alternate Mode EEC Max Climb %N1

Based on engine bleed for packs on and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KIAS OR MACH)											
	0	5	10	15	20	25	30	33	35	37	39	41
	280	280	280	280	280	280	280	0.78	0.78	0.78	0.78	0.78
60	80.8	81.3	84.0	86.0	88.3	90.3	93.1	94.6	95.7	96.0	95.4	94.7
55	81.6	81.6	83.3	85.3	87.7	89.6	92.4	93.9	94.9	95.2	94.6	94.0
50	82.6	82.5	82.8	84.7	87.0	88.9	91.7	93.1	94.2	94.5	93.9	93.3
45	83.6	83.4	83.6	84.0	86.3	88.2	90.9	92.4	93.5	93.8	93.2	92.6
40	84.5	84.5	84.5	84.3	85.6	87.5	90.2	91.7	92.7	93.0	92.4	91.8
35	85.2	85.5	85.5	85.2	85.2	86.8	89.5	91.0	92.0	92.3	91.7	91.1
30	84.5	86.5	86.5	86.2	85.7	86.1	88.8	90.2	91.2	91.5	91.0	90.4
25	83.8	86.6	87.5	87.1	86.6	87.7	88.0	89.5	90.5	90.8	90.2	89.6
20	83.1	85.8	88.4	88.0	87.5	88.7	89.2	89.1	89.7	90.0	89.4	88.9
15	82.3	85.1	87.8	89.0	88.5	89.8	90.2	90.5	89.6	89.2	88.7	88.1
10	81.6	84.3	87.1	89.4	89.5	90.9	91.1	91.3	91.0	90.0	89.5	88.9
5	80.8	83.6	86.3	88.7	90.6	91.9	91.9	92.0	91.8	91.1	90.7	90.1
0	80.1	82.8	85.5	87.9	89.9	92.9	92.6	92.6	92.3	91.8	91.3	90.6
-5	79.4	82.0	84.7	87.1	89.2	92.7	93.4	93.4	93.1	92.4	91.9	91.2
-10	78.6	81.2	84.0	86.4	88.3	91.9	93.6	94.3	94.0	93.2	92.6	91.8
-15	77.9	80.5	83.2	85.6	87.5	91.1	92.8	94.1	94.8	94.1	93.5	92.7
-20	77.1	79.7	82.4	84.8	86.7	90.2	91.9	93.2	94.4	94.4	93.9	93.1
-25	76.3	78.9	81.5	84.0	85.8	89.4	91.0	92.3	93.4	93.5	93.0	92.2
-30	75.6	78.1	80.7	83.2	85.0	88.5	90.1	91.4	92.5	92.6	92.1	91.3
-35	74.8	77.3	79.9	82.4	84.1	87.6	89.3	90.5	91.6	91.7	91.2	90.4
-40	74.0	76.5	79.0	81.5	83.3	86.7	88.4	89.6	90.7	90.7	90.2	89.5

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)											
	0	5	10	15	20	25	30	33	35	37	39	41
ENGINE ANTI-ICE	0.0	0.0	-0.6	-0.7	-0.8	-0.9	-1.2	-1.5	-1.8	-2.0	-2.1	-2.1
ENGINE & WING ANTI-ICE	0.0	0.0	-1.5	-1.7	-2.0	-2.1	-2.6	-3.2	-4.0	-4.2	-4.2	-4.2

ALTERNATE MODE EEC

Alternate Mode EEC Go-Around %N1

Based on engine bleed for packs on and anti-ice off

REPORTED OAT (°C)	TAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
59	60	85.8	86.3	86.8	86.9	86.4	86.0	85.5	85.0	84.6	84.2	83.8	83.3	82.9	81.9	81.0	79.9	79.0	78.6
54	55	87.2	87.6	88.0	88.0	87.6	87.1	86.7	86.2	85.8	85.3	84.9	84.5	84.0	83.1	82.2	81.1	80.2	79.8
49	50	88.1	88.7	89.3	89.0	88.6	88.2	87.8	87.3	86.9	86.5	86.1	85.6	85.1	84.2	83.3	82.3	81.4	81.0
44	45	89.1	89.7	90.2	90.1	89.8	89.1	88.8	88.4	88.0	87.5	87.1	86.7	86.2	85.3	84.4	83.4	82.5	82.1
39	40	90.0	90.6	91.2	91.1	91.0	90.9	90.4	89.6	89.0	88.6	88.2	87.8	87.3	86.4	85.5	84.5	83.6	83.2
34	35	90.8	91.5	92.1	92.1	92.0	91.9	91.8	91.6	91.2	90.3	89.1	88.8	88.3	87.5	86.6	85.6	84.8	84.4
29	30	90.1	91.4	92.7	92.7	92.7	92.7	92.7	92.6	92.6	92.5	90.0	89.7	89.3	88.5	87.7	86.8	85.9	85.5
24	25	89.3	90.6	91.9	92.2	92.5	92.8	92.9	93.1	93.2	93.1	91.0	90.6	90.2	89.5	88.7	87.9	87.1	86.7
19	20	88.5	89.8	91.0	91.4	91.7	92.0	92.3	92.6	92.8	93.0	91.9	91.6	91.2	90.5	89.7	89.0	88.2	87.8
14	15	87.7	89.0	90.2	90.5	90.8	91.2	91.5	91.8	92.1	92.4	92.8	92.6	92.3	91.5	90.8	90.1	89.4	89.0
9	10	86.9	88.2	89.4	89.7	90.0	90.3	90.7	91.0	91.3	91.6	92.0	92.4	92.8	92.5	91.9	91.3	90.6	90.2
4	5	86.1	87.4	88.6	88.9	89.2	89.5	89.9	90.2	90.5	90.8	91.2	91.6	92.0	92.0	92.0	92.1	91.7	91.3
-1	0	85.3	86.5	87.8	88.1	88.5	88.7	89.0	89.3	89.7	90.0	90.4	90.8	91.2	91.2	91.3	91.3	91.3	91.3
-6	-5	84.5	85.7	87.0	87.3	87.6	87.9	88.2	88.5	88.8	89.2	89.6	90.0	90.4	90.4	90.5	90.5	90.5	90.5
-11	-10	83.7	84.9	86.2	86.5	86.8	87.0	87.3	87.6	88.0	88.3	88.8	89.2	89.6	89.6	89.7	89.7	89.7	89.7
-16	-15	82.9	84.1	85.3	85.6	85.9	86.2	86.4	86.8	87.1	87.5	87.9	88.3	88.7	88.8	88.8	88.9	88.9	88.9
-21	-20	82.1	83.3	84.5	84.8	85.1	85.4	85.6	85.9	86.3	86.7	87.1	87.5	87.9	88.0	88.0	88.0	88.1	88.1
-26	-25	81.3	82.5	83.7	84.0	84.3	84.5	84.8	85.1	85.4	85.8	86.2	86.7	87.0	87.1	87.2	87.2	87.2	87.3
-31	-30	80.4	81.6	82.8	83.1	83.4	83.7	83.9	84.2	84.6	85.0	85.4	85.8	86.2	86.3	86.3	86.4	86.4	86.4
-36	-35	79.6	80.8	82.0	82.3	82.6	82.8	83.1	83.4	83.7	84.1	84.5	84.9	85.3	85.4	85.4	85.5	85.6	85.6
-41	-40	78.8	80.0	81.1	81.4	81.7	82.0	82.2	82.5	82.9	83.2	83.6	84.0	84.4	84.5	84.6	84.6	84.7	84.7
-46	-45	77.9	79.1	80.3	80.6	80.9	81.1	81.4	81.7	82.0	82.4	82.7	83.1	83.5	83.6	83.6	83.7	83.8	83.8
-51	-50	77.1	78.2	79.4	79.7	80.0	80.2	80.5	80.8	81.1	81.5	81.8	82.2	82.6	82.7	82.7	82.8	82.9	82.9

%N1 Adjustment forEngine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.5	0.5	0.6	0.6	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.1	1.2	1.4	1.6	1.7	1.8
A/C HIGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINE & WING ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	-1.4	-1.5	-1.4	-1.4	-1.5	-1.5
ENGINE & WING ANTI-ICE*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.8	-2.2	-2.3	-2.3	-2.3	-2.4	-2.5

***Single Bleed Source**

Performance Inflight — Chapter PI
Alternate Mode EEC — Section 15

ALTERNATE MODE EEC
ENGINE INOP

Alternate Mode EEC Initial Max Continuous %N1
Based on .79M, A/C high and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT)								
	25	27	29	31	33	35	37	39	41
20	88.8	88.5	88.1	88.7	88.0	88.1	88.3	87.7	87.1
15	89.9	89.5	89.1	89.6	89.4	88.4	87.6	87.0	86.4
10	91.0	90.5	90.1	90.5	90.3	89.9	88.7	88.2	87.6
5	91.4	91.4	91.0	91.3	91.2	90.8	90.1	89.6	89.0
0	90.7	91.6	91.8	92.2	92.0	91.6	90.9	90.2	89.4
-5	89.8	90.7	91.7	92.8	92.6	92.3	91.5	90.8	89.9
-10	88.8	89.7	90.8	92.4	93.3	93.1	92.3	91.5	90.6
-15	88.0	88.9	89.9	91.6	92.9	93.9	93.1	92.4	91.5
-20	87.2	88.1	89.1	90.7	92.0	93.3	93.2	92.6	91.7
-25	86.4	87.3	88.3	89.9	91.2	92.3	92.3	91.6	90.7
-30	85.6	86.4	87.4	89.0	90.3	91.4	91.4	90.7	89.8
-35	84.7	85.6	86.5	88.1	89.4	90.5	90.4	89.8	88.9
-40	83.9	84.7	85.7	87.3	88.5	89.6	89.5	88.8	88.0

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	25	27	29	31	33	35	37	39	41
ENGINE ANTI-ICE	-0.9	-1.0	-1.1	-1.2	-1.5	-1.8	-2.0	-2.1	-2.1
ENGINE & WING ANTI-ICE	-3.3	-3.5	-3.8	-4.1	-4.9	-6.1	-6.3	-6.4	-6.4

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Alternate Mode EEC Max Continuous %N1

Based on A/C high and anti-ice off

37000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
160	.51	87.9	88.8	89.8	90.8	91.8	91.9	91.9	91.9	91.5	90.5	89.5	89.9
200	.63	87.6	88.6	89.6	90.6	91.6	92.5	92.8	92.8	92.4	91.6	90.6	89.7
240	.74	87.1	88.1	89.0	90.0	91.0	91.9	92.9	93.5	93.1	92.1	91.3	90.7
280	.86	85.3	86.2	87.2	88.2	89.1	90.0	91.0	91.9	92.8	92.6	91.8	91.2

35000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
160	.49	87.9	88.9	89.9	90.9	91.8	92.1	92.1	92.1	92.1	91.4	90.2	90.0
200	.60	87.1	88.1	89.0	90.0	90.9	91.9	92.3	92.3	92.3	92.3	91.4	90.4
240	.71	87.1	88.1	89.1	90.0	90.9	91.9	92.8	93.5	93.4	92.8	92.0	91.3
280	.82	86.0	87.0	87.9	88.9	89.8	90.7	91.6	92.5	93.4	93.2	92.4	91.7

33000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
160	.47	88.9	89.9	90.8	91.8	92.6	92.6	92.6	92.2	91.6	90.8	89.5	89.9
200	.58	88.5	89.4	90.4	91.3	92.2	93.1	93.1	92.6	92.1	91.6	90.9	89.5
240	.68	87.8	88.8	89.7	90.6	91.5	92.4	93.3	93.4	92.8	92.2	91.6	90.6
280	.79	86.7	87.6	88.5	89.4	90.3	91.2	92.1	92.9	93.3	92.6	92.0	91.2
320	.89	85.3	86.3	87.2	88.0	88.9	89.8	90.6	91.5	92.3	93.3	93.1	92.3

31000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
160	.45	88.7	89.7	90.6	91.5	92.4	93.0	92.9	92.5	91.7	90.9	90.0	89.0
200	.55	88.6	89.5	90.4	91.3	92.2	93.1	93.6	93.2	92.3	91.6	91.0	89.8
240	.66	87.7	88.6	89.5	90.4	91.3	92.2	93.1	93.7	93.1	92.2	91.6	90.7
280	.76	86.1	87.0	87.9	88.8	89.7	90.5	91.4	92.2	93.1	92.7	92.1	91.2
320	.85	84.1	85.0	85.9	86.8	87.6	88.5	89.3	90.1	91.0	91.9	92.4	91.7

29000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
160	.43	89.0	89.9	90.8	91.8	92.7	92.9	92.3	91.3	90.5	89.8	88.2	87.9
200	.53	88.7	89.6	90.5	91.4	92.3	93.2	93.1	92.2	91.3	90.5	89.4	87.8
240	.63	88.0	88.9	89.8	90.7	91.6	92.5	93.3	92.9	92.0	91.1	90.1	89.0
280	.73	86.1	87.0	87.9	88.8	89.6	90.5	91.4	92.2	92.4	91.6	90.7	89.7
320	.82	84.0	84.9	85.8	86.6	87.5	88.3	89.2	90.0	90.9	91.8	91.1	90.3
360	.91	83.5	84.4	85.3	86.2	87.0	87.9	88.7	89.5	90.4	91.3	92.0	92.0

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	37	35	33	31	29
ENGINE ANTI-ICE	-2.0	-1.8	-1.5	-1.2	-1.1
ENGINE & WING ANTI-ICE	-6.1	-6.0	-4.8	-4.0	-3.7

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

27000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
160	.41	89.0	90.0	90.9	91.8	92.7	93.5	93.1	91.8	90.9	90.3	89.1	87.1
200	.51	88.2	89.2	90.1	91.0	91.8	92.7	93.3	92.5	91.7	91.0	89.8	88.6
240	.60	87.4	88.3	89.2	90.1	91.0	91.9	92.7	93.4	92.4	91.6	90.6	89.5
280	.70	85.7	86.6	87.5	88.4	89.2	90.1	90.9	91.7	92.7	92.1	91.1	90.0
320	.79	83.8	84.7	85.5	86.4	87.2	88.1	88.9	89.7	90.7	91.6	91.4	90.5
360	.88	82.6	83.5	84.4	85.2	86.1	86.9	87.7	88.5	89.5	90.4	91.1	91.6

25000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
160	.39	90.1	91.0	91.9	92.8	93.7	93.7	92.4	91.4	90.7	89.7	88.1	86.9
200	.49	89.0	89.9	90.8	91.6	92.5	93.4	93.1	92.1	91.3	90.3	89.1	87.5
240	.58	87.7	88.6	89.4	90.3	91.2	92.0	92.9	92.8	91.9	90.9	89.8	88.6
280	.67	86.2	87.0	87.9	88.8	89.6	90.5	91.3	92.2	92.4	91.5	90.4	89.2
320	.76	84.4	85.3	86.1	87.0	87.8	88.6	89.4	90.4	91.3	91.8	90.8	89.7
360	.85	82.6	83.4	84.3	85.1	85.9	86.7	87.5	88.4	89.3	90.0	90.8	90.2

24000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
160	.38	89.4	90.3	91.3	92.2	93.0	93.9	92.7	91.7	90.9	89.9	88.7	86.9
200	.48	88.9	89.8	90.7	91.6	92.5	93.4	93.8	92.8	91.8	90.9	89.8	88.6
240	.57	88.1	89.0	89.9	90.8	91.7	92.5	93.4	93.7	92.8	91.8	90.8	89.7
280	.66	86.7	87.6	88.5	89.4	90.2	91.1	91.9	92.7	93.3	92.4	91.4	90.3
320	.75	85.0	85.9	86.8	87.7	88.5	89.3	90.2	91.0	91.8	92.6	91.8	90.8
360	.83	83.2	84.1	85.0	85.8	86.6	87.5	88.3	89.1	89.9	90.6	91.4	91.3

22000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
160	.37	88.2	89.1	89.9	90.8	91.7	92.0	91.2	90.3	89.4	88.3	87.2	86.5
200	.46	87.9	88.8	89.7	90.6	91.4	92.3	92.2	91.4	90.4	89.3	88.3	87.1
240	.55	88.9	89.8	90.7	91.6	92.4	93.3	94.1	93.8	92.9	92.0	91.0	89.9
280	.63	87.7	88.6	89.5	90.4	91.2	92.1	92.9	93.7	93.5	92.5	91.5	90.5
320	.72	86.2	87.1	87.9	88.8	89.6	90.5	91.3	92.1	92.9	93.0	92.1	91.1
360	.80	84.5	85.4	86.2	87.1	87.9	88.7	89.5	90.3	91.1	91.9	92.4	91.5

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

20000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
160	.35	86.4	87.3	88.2	89.0	89.9	90.7	90.7	89.9	88.9	87.8	86.7	85.9
200	.44	86.0	86.9	87.8	88.6	89.5	90.3	91.1	90.6	89.5	88.4	87.3	86.2
240	.53	88.7	89.6	90.5	91.4	92.3	93.1	94.0	94.7	94.0	93.0	92.0	91.0
280	.61	88.0	88.9	89.8	90.7	91.6	92.4	93.3	94.1	94.8	93.8	92.9	92.0
320	.69	86.6	87.5	88.3	89.2	90.1	90.9	91.7	92.6	93.4	94.2	93.5	92.6
360	.77	85.1	85.9	86.8	87.6	88.4	89.3	90.1	90.9	91.7	92.5	93.3	92.9

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	27	25	24	22	20
ENGINE ANTI-ICE	-0.9	-0.9	-0.8	-0.9	-0.8
ENGINE & WING ANTI-ICE	-3.4	-3.3	-3.3	-3.3	-3.2

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

18000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
160	.34	86.6	87.4	88.3	89.1	89.9	90.7	90.2	89.2	88.1	87.0	85.9	85.1
200	.42	85.9	86.8	87.6	88.4	89.2	90.0	90.5	89.9	88.8	87.6	86.5	85.6
240	.51	88.6	89.4	90.3	91.1	92.0	92.8	93.6	93.8	93.1	92.1	90.9	90.0
280	.59	89.1	90.0	90.8	91.7	92.5	93.3	94.2	95.0	94.9	94.1	93.2	92.4
320	.67	87.8	88.7	89.5	90.4	91.2	92.0	92.8	93.6	94.4	94.6	93.8	92.9
360	.75	86.5	87.3	88.1	88.9	89.8	90.6	91.4	92.2	92.9	93.7	94.1	93.3

16000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
160	.33	85.9	86.8	87.6	88.4	89.2	90.0	90.5	89.6	88.5	87.3	86.2	85.2
200	.41	85.3	86.1	86.9	87.7	88.5	89.3	90.1	90.0	89.1	87.9	86.8	85.8
240	.49	86.3	87.1	87.9	88.7	89.5	90.3	91.2	92.0	91.9	90.9	89.8	88.7
280	.57	89.0	89.9	90.7	91.6	92.4	93.2	94.0	94.9	95.7	94.9	94.1	93.3
320	.64	87.8	88.7	89.5	90.4	91.2	92.0	92.8	93.6	94.4	95.2	94.7	93.8
360	.72	86.6	87.4	88.3	89.1	89.9	90.7	91.5	92.3	93.1	93.9	94.7	94.2

14000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
160	.31	86.4	87.3	88.1	88.9	89.7	90.5	90.5	89.6	88.5	87.4	86.4	85.3
200	.39	85.8	86.6	87.4	88.2	89.0	89.7	90.5	90.1	89.1	88.0	86.9	85.9
240	.47	85.4	86.2	87.1	87.8	88.6	89.4	90.2	90.9	90.9	89.8	88.8	87.7
280	.54	89.1	90.0	90.8	91.6	92.5	93.3	94.1	94.9	95.2	94.4	93.5	92.6
320	.62	88.3	89.2	90.0	90.8	91.7	92.5	93.3	94.0	94.8	95.0	94.3	93.4
360	.69	86.6	87.5	88.3	89.1	89.9	90.7	91.5	92.3	93.0	93.8	94.2	93.7

12000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	35
160	.30	87.1	87.9	88.7	89.6	90.4	91.2	91.2	90.4	89.4	88.4	87.4	86.4
200	.38	86.3	87.1	88.0	88.8	89.6	90.4	91.0	90.9	89.9	89.0	88.0	87.0
240	.45	85.5	86.3	87.1	87.9	88.7	89.5	90.3	90.7	90.3	89.5	88.6	87.6
280	.52	88.5	89.4	90.2	91.1	91.9	92.7	93.5	94.3	94.3	93.7	92.8	91.9
320	.60	88.3	89.1	89.9	90.8	91.6	92.4	93.2	94.0	94.8	94.3	93.4	92.6
360	.67	86.1	87.0	87.8	88.6	89.4	90.2	91.0	91.7	92.5	93.3	93.0	92.5

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	18	16	14	12
ENGINE ANTI-ICE	-0.9	-0.7	-0.7	-0.7
ENGINE & WING ANTI-ICE	-3.2	-3.0	-2.9	-2.7

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

10000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	35
160	.29	87.0	87.8	88.7	89.5	90.3	91.1	91.9	91.9	91.3	90.4	89.5	88.6
200	.36	86.3	87.2	88.0	88.8	89.6	90.5	91.3	91.7	91.5	90.9	90.0	89.1
240	.43	85.6	86.4	87.3	88.1	88.9	89.7	90.5	91.3	91.4	91.3	90.4	89.4
280	.51	88.2	89.0	89.9	90.7	91.6	92.4	93.2	94.0	94.7	93.9	93.0	92.1
320	.58	87.3	88.2	89.0	89.8	90.7	91.5	92.3	93.1	93.9	94.3	93.4	92.5
360	.65	84.5	85.3	86.1	86.9	87.7	88.5	89.3	90.1	90.9	91.6	92.1	92.1

5000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-10	-5	0	5	10	15	20	25	30	35	40	45
160	.26	86.8	87.7	88.5	89.3	90.1	90.9	91.6	91.3	90.4	89.5	88.6	87.6
200	.33	86.4	87.2	88.1	88.9	89.7	90.5	91.3	91.5	90.9	89.9	88.9	88.0
240	.40	85.9	86.7	87.6	88.4	89.2	90.0	90.8	91.4	91.3	90.4	89.5	88.5
280	.46	85.7	86.5	87.3	88.2	89.0	89.8	90.6	91.4	91.6	91.1	90.2	89.3
320	.53	85.5	86.3	87.1	88.0	88.8	89.6	90.4	91.1	91.9	91.8	91.3	90.5
360	.59	81.5	82.3	83.1	83.8	84.6	85.4	86.1	86.9	87.6	88.4	88.4	88.4

3000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-5	0	5	10	15	20	25	30	35	40	45	50
160	.26	86.8	87.7	88.5	89.3	90.1	90.9	91.2	90.5	89.6	88.6	87.6	86.6
200	.32	86.5	87.3	88.1	88.9	89.7	90.5	91.3	90.8	89.9	89.0	88.0	87.0
240	.38	86.1	86.9	87.7	88.5	89.2	90.0	90.8	91.1	90.4	89.5	88.5	87.5
280	.45	85.4	86.2	87.0	87.8	88.6	89.4	90.2	91.0	90.7	89.9	89.0	88.1
320	.51	84.7	85.5	86.3	87.1	87.9	88.6	89.4	90.2	90.9	90.8	90.0	89.3
360	.57	80.5	81.3	82.0	82.8	83.5	84.2	85.0	85.7	86.4	86.9	86.9	86.9

1000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-5	0	5	10	15	20	25	30	35	40	45	50
160	.25	85.9	86.7	87.5	88.3	89.1	89.9	90.7	90.4	89.6	88.7	87.7	86.7
200	.31	85.5	86.3	87.1	87.9	88.7	89.5	90.3	90.7	89.9	89.0	88.0	87.0
240	.37	85.2	86.0	86.8	87.6	88.4	89.1	89.9	90.7	90.3	89.4	88.5	87.5
280	.43	84.6	85.4	86.2	87.0	87.8	88.5	89.3	90.1	90.6	89.9	89.0	88.1
320	.49	82.6	83.4	84.2	84.9	85.7	86.5	87.2	88.0	88.7	89.0	88.9	88.6
360	.55	78.8	79.6	80.3	81.0	81.8	82.5	83.2	83.9	84.6	85.3	85.5	85.5

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	10	5	3	1
ENGINE ANTI-ICE	-0.6	0.0	0.0	0.0
ENGINE & WING ANTI-ICE	-2.5	0.0	0.0	0.0

Intentionally
Blank

Performance Inflight — Chapter PI
Gear Down — Section 16

GEAR DOWN

Long Range Cruise Altitude Capability
Max Cruise Thrust, 100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
85	16500	13900	11200
80	18800	16500	13800
75	21500	19000	16500
70	24900	22400	19300
65	27000	25700	23800
60	29100	27900	26700
55	31300	30400	29100
50	33300	32700	32100
45	35600	34900	34500
40	38000	37500	37100

GEAR DOWN

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)									
		10	21	23	25	27	29	31	33	35	37
85	%N1	79.7									
	MACH	.466									
	KIAS	258									
	FF/ENG	1909									
80	%N1	77.8	88.0								
	MACH	.453	.559								
	KIAS	250	251								
	FF/ENG	1789	1834								
75	%N1	75.7	86.0	88.1							
	MACH	.439	.541	.564							
	KIAS	242	242	243							
	FF/ENG	1666	1699	1720							
70	%N1	73.6	83.9	85.9	88.1						
	MACH	.424	.524	.546	.568						
	KIAS	234	234	234	235						
	FF/ENG	1547	1572	1588	1606						
65	%N1	71.3	81.8	83.7	85.7	87.8					
	MACH	.408	.506	.526	.549	.572					
	KIAS	225	226	226	226	226					
	FF/ENG	1431	1452	1458	1474	1491					
60	%N1	68.9	79.6	81.4	83.3	85.4	87.5				
	MACH	.393	.488	.507	.528	.551	.574				
	KIAS	217	218	217	217	218	217				
	FF/ENG	1323	1335	1337	1343	1359	1375				
55	%N1	66.4	77.1	79.0	80.8	82.7	84.9	87.1			
	MACH	.376	.468	.487	.507	.528	.552	.574			
	KIAS	208	209	209	208	208	209	208			
	FF/ENG	1221	1221	1222	1223	1228	1243	1259			
50	%N1	63.9	74.3	76.3	78.2	80.1	82.0	84.2	86.3		
	MACH	.360	.447	.466	.485	.505	.527	.551	.574		
	KIAS	199	199	199	199	199	199	199	199		
	FF/ENG	1121	1105	1108	1109	1108	1112	1127	1144		
45	%N1	61.2	71.1	73.2	75.2	77.2	79.1	81.0	83.2	85.4	
	MACH	.345	.424	.443	.462	.481	.502	.523	.547	.572	
	KIAS	190	189	189	189	189	189	189	189	189	
	FF/ENG	1023	997	993	996	996	994	998	1011	1028	
40	%N1	58.2	67.6	69.7	71.7	73.9	75.9	77.8	79.7	81.8	84.5
	MACH	.328	.400	.418	.436	.456	.475	.496	.517	.541	.567
	KIAS	181	178	178	178	179	179	178	178	178	179
	FF/ENG	927	899	887	881	891	886	883	886	895	921

GEAR DOWN

Long Range Cruise Enroute Fuel and Time

Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
331	294	263	238	218	200	188	178	168	160	153
670	594	528	477	436	400	377	357	338	321	306
1012	896	796	718	655	600	566	534	506	481	459
1359	1200	1065	959	874	800	754	712	675	641	612
1711	1508	1336	1202	1094	1000	943	890	843	801	764
2066	1819	1609	1446	1314	1200	1131	1067	1010	960	915
2427	2133	1883	1690	1534	1400	1318	1244	1178	1118	1066
2792	2449	2159	1934	1755	1600	1507	1421	1345	1276	1216
3162	2769	2437	2180	1976	1800	1694	1598	1511	1434	1366
3538	3093	2716	2427	2198	2000	1882	1774	1677	1591	1515
3919	3420	2999	2676	2420	2200	2069	1950	1843	1748	1664

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		20		24		28	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	2.0	0:51	1.8	0:48	1.6	0:45	1.4	0:43	1.3	0:41
400	4.0	1:40	3.7	1:34	3.3	1:27	3.1	1:22	2.9	1:18
600	6.1	2:30	5.6	2:21	5.1	2:09	4.8	2:02	4.5	1:55
800	8.1	3:20	7.5	3:09	6.8	2:52	6.4	2:42	6.0	2:33
1000	10.0	4:12	9.3	3:57	8.5	3:35	8.0	3:23	7.5	3:11
1200	12.0	5:05	11.1	4:46	10.1	4:20	9.5	4:04	9.0	3:49
1400	13.9	5:58	12.9	5:37	11.8	5:05	11.1	4:46	10.5	4:28
1600	15.7	6:53	14.7	6:28	13.4	5:51	12.6	5:28	11.9	5:08
1800	17.6	7:48	16.4	7:20	15.0	6:37	14.1	6:12	13.3	5:48
2000	19.4	8:44	18.1	8:13	16.5	7:25	15.5	6:55	14.7	6:29
2200	21.1	9:42	19.8	9:07	18.1	8:13	17.0	7:40	16.0	7:10

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	40	50	60	70	80
2	-0.3	-0.1	0.0	0.2	0.6
4	-0.6	-0.3	0.0	0.5	1.2
6	-0.9	-0.5	0.0	0.7	1.7
8	-1.3	-0.6	0.0	0.9	2.2
10	-1.6	-0.8	0.0	1.2	2.7
12	-1.9	-1.0	0.0	1.4	3.2
14	-2.2	-1.1	0.0	1.6	3.6
16	-2.5	-1.3	0.0	1.8	4.0
18	-2.8	-1.4	0.0	2.0	4.4
20	-3.2	-1.6	0.0	2.2	4.7
22	-3.5	-1.8	0.0	2.4	5.1

GEAR DOWN

Descent
VREF40+70 KIAS

PRESSURE ALTITUDE (FT)	TIME (MIN)	FUEL (KG)	DISTANCE (NM)
41000	20.8	220	92
39000	20.1	215	87
37000	19.3	210	82
35000	18.6	205	78
33000	17.9	200	73
31000	17.2	195	69
29000	16.4	190	65
27000	15.6	185	60
25000	14.8	179	56
23000	14	173	52
21000	13.2	167	48
19000	12.3	160	44
17000	11.5	153	40
15000	10.6	146	36
10000	8.3	126	26
5000	5.8	103	16
1500	4	84	10

Allowances for a straight-in approach are included.

GEAR DOWN

Holding

Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)							
		1500	5000	10000	15000	20000	25000	30000	35000
85	%N1	69.2	72.3	77.1	82.0	86.9			
	KIAS	233	233	233	233	234			
	FF/ENG	1820	1810	1820	1850	1890			
80	%N1	67.5	70.4	75.2	80.1	85.0			
	KIAS	226	226	226	226	227			
	FF/ENG	1710	1700	1710	1730	1760			
75	%N1	65.7	68.5	73.2	78.1	83.0	88.5		
	KIAS	219	219	219	219	219	221		
	FF/ENG	1600	1600	1590	1610	1630	1690		
70	%N1	63.8	66.6	71.1	76.0	81.0	86.1		
	KIAS	214	214	214	214	214	214		
	FF/ENG	1500	1490	1490	1500	1520	1550		
65	%N1	62.0	64.8	69.1	74.0	78.9	83.9		
	KIAS	210	210	210	210	210	210		
	FF/ENG	1410	1400	1400	1400	1410	1430		
60	%N1	60.1	62.8	67.0	71.8	76.8	81.6	87.1	
	KIAS	204	204	204	204	204	204	204	
	FF/ENG	1320	1310	1310	1300	1300	1320	1360	
55	%N1	58.0	60.6	64.9	69.5	74.4	79.4	84.5	
	KIAS	198	198	198	198	198	198	198	
	FF/ENG	1240	1220	1220	1200	1200	1210	1230	
50	%N1	55.9	58.4	62.6	67.1	71.9	77.0	81.9	
	KIAS	191	191	191	191	191	191	191	
	FF/ENG	1150	1140	1130	1110	1110	1110	1120	
45	%N1	53.8	56.2	60.2	64.6	69.3	74.4	79.4	84.6
	KIAS	185	185	185	185	185	185	185	185
	FF/ENG	1060	1060	1040	1040	1030	1010	1020	1050
40	%N1	51.6	53.8	57.6	62.0	66.6	71.6	76.7	81.7
	KIAS	178	178	178	178	178	178	178	178
	FF/ENG	980	970	950	950	950	920	920	930

This table includes 5% additional fuel for holding in a racetrack pattern.

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Performance Inflight — Chapter PI
Gear Down, Engine Inop — Section 17

GEAR DOWN

ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

100 ft/min residual rate of climb

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFTDOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
80	77	225	2400		
75	72	219	4800	3300	1400
70	67	214	6900	5800	4400
65	62	209	9200	8200	7000
60	57	204	11200	10400	9600
55	53	198	13200	12100	11300
50	48	191	15500	14100	13000
45	43	185	18600	16800	14800
40	38	177	22000	20200	18400

Includes APU fuel burn.

GEAR DOWN
ENGINE INOP
MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability
100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
70	2900		
65	5700	4200	1800
60	8400	7300	5800
55	11000	10200	9300
50	13500	12400	11500
45	16600	14800	13600
40	20700	18900	16900

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)								
		5	7	9	11	13	15	17	19	21
70	%N1	89.7	91.8							
	MACH	.386	.400							
	KIAS	233	234							
	FF/ENG	3176	3210							
65	%N1	87.2	89.2	91.3						
	MACH	.372	.386	.401						
	KIAS	225	225	225						
	FF/ENG	2923	2942	2973						
60	%N1	84.8	86.6	88.5	90.7					
	MACH	.359	.371	.385	.400					
	KIAS	217	217	217	217					
	FF/ENG	2689	2691	2707	2735					
55	%N1	82.3	84.0	85.8	87.7	89.8				
	MACH	.346	.357	.370	.383	.399				
	KIAS	210	208	208	208	208				
	FF/ENG	2470	2460	2460	2473	2497				
50	%N1	79.4	81.3	83.0	84.7	86.6	88.7			
	MACH	.333	.344	.355	.367	.380	.396			
	KIAS	201	200	199	198	198	198			
	FF/ENG	2256	2245	2233	2230	2240	2258			
45	%N1	76.1	78.1	79.9	81.7	83.4	85.2	87.4	89.7	
	MACH	.318	.328	.339	.351	.362	.376	.391	.407	
	KIAS	192	191	191	190	189	188	188	188	
	FF/ENG	2037	2031	2021	2009	2004	2008	2021	2046	
40	%N1	72.5	74.4	76.3	78.2	80.0	81.8	83.6	85.6	87.9
	MACH	.302	.312	.322	.334	.345	.357	.369	.384	.400
	KIAS	182	182	181	180	179	178	178	178	178
	FF/ENG	1820	1813	1808	1800	1790	1781	1778	1786	1804

Includes APU fuel burn.

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
168	149	132	119	109	100	93	88	83	78	75
343	302	267	240	219	200	187	174	164	155	147
518	455	402	361	328	300	280	261	245	231	219
695	610	538	483	438	400	373	348	327	308	292
873	765	674	604	548	500	466	435	408	384	363
1053	922	812	726	659	600	558	521	488	459	435
1233	1079	948	848	769	700	651	608	569	536	507
1415	1237	1086	970	879	800	744	694	650	611	578
1597	1395	1224	1093	989	900	837	780	730	687	650
1782	1555	1363	1216	1100	1000	929	866	810	762	721

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT) 6		10		14	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
100	1.0	0:27	0.9	0:26	0.8	0:25
200	2.2	0:53	2.0	0:51	1.9	0:48
300	3.3	1:19	3.0	1:15	2.9	1:11
400	4.4	1:45	4.1	1:40	3.9	1:34
500	5.5	2:11	5.1	2:05	4.9	1:58
600	6.5	2:38	6.2	2:30	5.9	2:21
700	7.6	3:04	7.2	2:55	6.9	2:45
800	8.6	3:31	8.2	3:21	7.8	3:09
900	9.7	3:59	9.1	3:46	8.8	3:33
1000	10.7	4:26	10.1	4:12	9.7	3:58

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG) 40	50	60	70	80
1	-0.2	-0.1	0.0	0.2	0.4
2	-0.4	-0.2	0.0	0.4	1.0
3	-0.6	-0.3	0.0	0.6	1.5
4	-0.7	-0.4	0.0	0.8	1.9
5	-0.9	-0.5	0.0	1.0	2.4
6	-1.1	-0.5	0.0	1.2	2.8
7	-1.3	-0.6	0.0	1.4	3.2
8	-1.5	-0.7	0.0	1.5	3.5
9	-1.7	-0.8	0.0	1.7	3.9
10	-1.9	-0.9	0.0	1.8	4.2
11	-2.1	-1.0	0.0	1.9	4.5

Includes APU fuel burn.

GEAR DOWN
ENGINE INOP
MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT) 1500	5000	10000	15000	20000
85	%N1	89.9				
	KIAS	233				
	FF/ENG	3730				
80	%N1	87.8	91.5			
	KIAS	226	226			
	FF/ENG	3480	3530			
75	%N1	85.7	89.2			
	KIAS	219	219			
	FF/ENG	3240	3270			
70	%N1	83.5	87.0			
	KIAS	214	214			
	FF/ENG	3000	3030			
65	%N1	81.4	84.8	89.9		
	KIAS	210	210	210		
	FF/ENG	2810	2820	2880		
60	%N1	79.1	82.5	87.4		
	KIAS	204	204	204		
	FF/ENG	2600	2610	2650		
55	%N1	76.5	80.0	85.0		
	KIAS	198	198	198		
	FF/ENG	2400	2410	2430		
50	%N1	73.9	77.3	82.4	87.3	
	KIAS	191	191	191	191	
	FF/ENG	2210	2220	2230	2260	
45	%N1	71.1	74.4	79.6	84.5	90.2
	KIAS	185	185	185	185	185
	FF/ENG	2030	2030	2040	2060	2110
40	%N1	68.3	71.4	76.5	81.6	86.7
	KIAS	178	178	178	178	178
	FF/ENG	1860	1850	1850	1860	1880

This table includes 5% additional fuel for holding in a racetrack pattern.
Includes APU fuel burn.

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Performance Inflight — Chapter PI
Text — Section 18

Introduction

This chapter contains information to supplement performance data from the Flight Management Computer (FMC). In addition, sufficient inflight data is provided to complete a flight with the FMC inoperative. In the event of conflict between data presented in this chapter and that contained in the approved Airplane Flight Manual, the Flight Manual shall always take precedence.

General

Takeoff Speeds

The speeds presented in the Takeoff Speeds table, as well as FMC computed takeoff speeds, can be used for all performance conditions except where adjustments must be made for anti-skid inoperative, thrust reversers inoperative, improved climb, contaminated runway situations, or brake energy limits.

V1 adjustments are not necessary for equal amounts of clearway and stopway. V1 for takeoff limit weights based on unequal clearway and stopway should be obtained from computerized takeoff speed calculations for the specific takeoff conditions.

These speeds may be used for weights less than or equal to the performance limited weight subject to the restrictions noted above.

The FMC will protect minimum control speeds by increasing V1, VR, and V2 as required. However, the FMC will not compute takeoff speeds for weights where the required speed increase exceeds the maximum certified speed increase. This typically occurs at full rated thrust and light weights. In this case, the message "V SPEEDS UNAVAILABLE" will appear on the FMC scratchpad and the takeoff speed entries will be blank. In this situation, manually verify takeoff speeds using an approved source of takeoff performance information. Upon verifying takeoff speeds, takeoff is permitted. When the selected takeoff speeds cannot be verified, the options are to select a lower flap setting, select derate thrust and/or increase airplane gross weight (e.g. add fuel). Selecting derate thrust is the preferred method as this will reduce the minimum control speeds. Note that the assumed temperature method will not help this condition as the minimum control speeds are determined at the actual temperature and therefore are not reduced by an assumed temperature selection.

Takeoff speeds are determined as follows:

1. Determine V1, VR, and V2 from the Takeoff Speeds table (Table 1) with brake release weight.
2. Adjust V1, VR, and V2 for temperature and pressure altitude from the V1, VR, V2 Adjustments table (Table 2).
3. Adjust V1 for wind and slope from the Slope and Wind V1 Adjustments table (Table 3).
4. Determine V1(MCG) from the V1(MCG) table (Table 4).
5. If V1 from Step 3 is less than V1(MCG), set V1=V1(MCG).
6. If the VR from Step 2 is less than V1(MCG), set VR equal to V1(MCG) and determine a new V2 by adding the difference between the VR from Step 2 and V1(MCG) to the normal V2.

Note: Regulations prohibit scheduling takeoff with a V1 less than minimum V1 for control on the ground, V1(MCG). It is therefore necessary to compare the adjusted V1 to V1(MCG). The V1(MCG) presented in this manual is conservative for all weight and bleed configurations. No takeoff weight adjustment is necessary provided that the actual field length exceeds the minimum field length shown in the Field and Climb Limit Weight table in the chapter Performance Dispatch.

Stabilizer Trim Setting

To find takeoff stabilizer trim setting, enter the Stabilizer Trim Setting table with anticipated brake release weight and center of gravity (C.G. % MAC) and read required stabilizer trim units.

VREF

This table contains flaps 40, 30 and 15 reference speeds for a given weight for a reference pressure altitude of 14500 feet. These data are consistent with the FMC. The FMC uses a reference pressure altitude of 14500 feet to calculate VREF when the origin or destination airports have not been defined. For similar conditions, VREF values at 14500 feet are conservative for lower pressure altitudes.

Flap Maneuver Speeds

This table provides flap maneuver speeds for various flap settings. During flap retraction, selection of the next flap position is initiated when reaching the maneuver speed for the existing flap position. During flap retraction, at least adequate maneuver capability of 30° of bank (15° of bank and 15° overshoot) to stick shaker is provided at the flap retraction speed. Full maneuvering capability of at least 40° of bank (25° of bank and 15° overshoot) is provided when the airplane has accelerated to the recommended maneuver speed for the selected flap position.

During flap extension, selection of the flaps to the next flap position should be made when approaching, and before decelerating below, the maneuver speed for the existing flap position. The flap extension speed schedule varies with airplane weight and provides full maneuver capability of at least 40° of bank (25° of bank and 15° overshoot) to stick shaker at all weights.

Slush/Standing Water Takeoff

Experience has shown that aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water or ice. Therefore, reductions in runway/obstacle limited takeoff weight and revised takeoff speeds are necessary. The tables are intended for guidance in accordance with advisory material and assume an engine failure at the critical point during the takeoff.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore this information is conservative when operating under typical colder weather conditions where patches of slush exist and some degree of sanding is common. Takeoffs in slush depths greater than 0.5 inches (13 mm) are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

Takeoff weight is determined as follows:

1. Determine the dry field/obstacle limit weight for the takeoff flap setting.
2. Enter the Weight Adjustment table (Table 1) with the dry field/obstacle limit weight to obtain the weight reduction for the slush/standing water depth and airport pressure altitude.
3. Adjust field length available for temperature by the amount provided in the notes below the V1(MCG) Limit Weight table (Table 2).

4. Enter the V1(MCG) Limit Weight table (Table 2) with the adjusted field length and pressure altitude to obtain the slush/standing water limit weight with respect to minimum field length required for V1(MCG) speed.
5. The maximum allowable takeoff weight in slush/standing water is the lesser of the limit weights found in steps 2 and 4.

Takeoff speed determination:

1. Determine takeoff speeds V1, VR and V2 for actual brake release weight using the Dry Runway Takeoff Speeds tables in this section.
2. If V1(MCG) limited, set V1=V1(MCG). If not limited by V1(MCG) considerations, enter the V1 Adjustment table (Table 3) with actual brake release weight to determine the V1 reduction to apply to V1 speed. If the adjusted V1 is less than V1(MCG), set V1=V1(MCG).

Dry Snow Runway Takeoff

In addition to slush/standing water, the data are provided for dry snow covered runways. Takeoff in dry snow depths greater than 4.0 inches (100 mm) is not recommended. The tables provided are used in the same manner as the Slush/Standing Water Takeoff tables.

Wet Snow Runway Takeoff

In addition to slush/standing water and dry snow, data are provided for wet snow covered runways. The tables provided are used in the same manner as the Slush/Standing Water Takeoff tables.

Slippery Runway Takeoff

Airplane braking action is reported as good, medium or poor, depending on existing runway conditions. If braking action is reported as good, conditions should not be expected to be as good as on clean, dry runways. The value “good” is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when stopping. The performance level of good is the same as used by the FAA and EASA to define wet runway rejected takeoff performance. A braking action of good to medium (interpolation between good and medium) is representative of a runway covered with compacted snow. Similarly, poor braking action is representative of a runway covered with ice. Performance is based on reversers operating and a 15 ft screen height at the end of the runway. The tables provided are used in the same manner as the Slush/Standing Water tables.

One Thrust Reverser Inoperative

Wet runway takeoff performance presented for all brakes operating is based on the use of one thrust reverser during deceleration. When operating with a thrust reverser inoperative, the runway/obstacle limited takeoff weight and V1 speed must be reduced to account for the reduced deceleration capability.

A simplified method which conservatively accounts for this is to reduce the normal wet runway/obstacle limited weight by 1250 kg and the V1 associated with the reduced weight by two knots.

If the resulting V1 is less than V1(MCG), takeoff is permitted with V1 set equal to V1(MCG) provided the accelerate stop distance available corrected for wind and slope exceeds approximately 1400 m.

Anti-Skid Inoperative

When operating with anti-skid inoperative, the field limit weight and V1 must be reduced to account for the effect on accelerate-stop performance. Anti-skid inoperative is only allowed on a dry runway. A simplified method which conservatively accounts for the effects of anti-skid inoperative is to reduce the normal dry field/obstacle limited weight by 8700 kg and the V1 associated with the reduced weight by the amount shown in the table below.

ANTI-SKID INOPERATIVE V1 ADJUSTMENTS	
FIELD LENGTH (M)	V1 ADJUSTMENT (KIAS)
2000	-22
2500	-19
3000	-16
3500	-14
4000	-12

If the resulting V1 is less than V1(MCG), takeoff is permitted with V1 set equal to V1(MCG) provided the dry accelerate-stop distance available adjusted for wind and slope exceeds approximately 2000 m.

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Takeoff %N1

To find Max Takeoff %N1 based on normal engine bleed for air conditioning packs on, enter Takeoff %N1 Table with airport pressure altitude and airport OAT and read %N1. Apply %N1 adjustments as provided when applicable.

Assumed Temperature Reduced Thrust

Regulations permit the use of up to 25% takeoff thrust reduction for operation with assumed temperature reduced thrust. Use of assumed temperature reduced thrust is not allowed with anti-skid inoperative or on runways contaminated with standing water, ice, slush, or snow. Use of assumed temperature reduced thrust is not recommended if potential windshear conditions exist.

To find the maximum allowable assumed temperature enter the Maximum Assumed Temperature table with airport pressure altitude and OAT. Compare this temperature to that at which the airplane is performance limited as determined from available takeoff performance data. Next, enter the Maximum Takeoff %N1 table with airport pressure altitude and the lower of the two temperatures previously determined, to obtain a maximum takeoff %N1. Do not use an assumed temperature less than the minimum assumed temperature shown. Enter the %N1 Adjustment table with OAT and the difference between the assumed and actual OAT to obtain a %N1 adjustment. Subtract the %N1 adjustment from the maximum takeoff %N1 found previously to determine the assumed temperature reduced thrust %N1.

Apply %N1 adjustments as provided when applicable.

Max Climb %N1

This table shows Max Climb %N1 for a 280/.78 climb speed schedule. Enter the table with airport pressure altitude and TAT and read %N1. Apply %N1 adjustments as provided when applicable.

Go-Around %N1

To find Go-Around %N1, enter the Go-Around %N1 table with airport pressure altitude and reported OAT or TAT and read %N1. Apply %N1 adjustments as provided when applicable.

Flight with Unreliable Airspeed/ Turbulent Air Penetration

Information is provided for use in all phases of flight in the event of unreliable airspeed/Mach indications resulting from blocking or freezing of the pitot system. Loss of radome or turbulent air may also cause unreliable airspeed/Mach indications. The cruise table in this section may also be used for turbulent air penetration. These speeds provide ample protection from stall and high speed buffet, while also providing protection from exceeding the structural limits. For climb, cruise, and descent these tables are based on a speed schedule of 280 KIAS below crossover altitude and .76 Mach above crossover altitude.

Pitch attitude and power setting are shown in bold type to emphasize pilot action. Altitude and/or vertical speed indications may also be unreliable.

All Engines

Long Range Cruise Maximum Operating Altitude

These tables provide the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. Note that these tables consider both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 100 ft/min residual rate of climb.

For FAA operators adhering to EASA standards, refer to the data for buffet limits corresponding to a maneuver margin of 1.3g (39° bank).

Flying above these altitudes with sustained banks in excess of approximately 13° may cause the airplane to lose speed and/or altitude. The altitudes shown in the table are limited to the maximum certified altitude of 41000 ft.

Long Range Cruise Control

This table provides target %N1, Long Range Cruise Mach number, IAS and standard day fuel flow per engine for the airplane weight and pressure altitude. As indicated by the shaded area, at optimum altitude, .79 Mach approximates the Long Range Cruise Mach schedule.

APU Operation During Flight

For APU operation during flight, increase fuel flow according to the table in the Engine Inoperative text section.

Long Range Cruise Enroute Fuel and Time

Long Range Cruise Enroute Fuel and Time tables are provided to determine remaining time and fuel required to destination. The data is based on Long Range Cruise and .78/280/250 descent. Tables are presented for low altitudes for shorter trip distances and high altitudes for longer trip distances.

To determine remaining fuel and time required, first enter the Ground to Air Miles Conversion table (Table 1) to convert ground distance and enroute wind to an equivalent still air distance. Next, enter the Reference Fuel and Time table (Table 2) with air distance from Table 1 and the desired altitude and read reference fuel and time required. Lastly, enter the Fuel Required Adjustment table (Table 3) with the reference fuel and the actual weight at checkpoint to obtain fuel required to destination.

Long Range Cruise Wind-Altitude Trade

Wind is a factor which may justify operations considerably below optimum altitude. For example, a favorable wind component may have an effect on ground speed which more than compensates for the loss in air range.

Using this table, it is possible to determine the break-even wind (advantage necessary or disadvantage that can be tolerated) to maintain the same range at another altitude and long range cruise speed. The tables make no allowance for climb or descent time, fuel or distance, and are based on comparing ground fuel mileage.

Descent at .78/280/250

Distance and time for descent are shown for a .78/280/250 descent speed schedule. Enter the table with top of descent pressure altitude and read distance in nautical miles and time in minutes. Data is based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach with gear down and landing flaps at the outer marker.

Holding

Target %N1, indicated airspeed and fuel flow per engine information is tabulated for holding with Flaps Up based on the FMC optimum holding speed schedule. This is the higher of the maximum endurance speed and the maneuvering speed. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read %N1, IAS and fuel flow per engine.

Advisory Information

Runway Surface Condition Correlation

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. A table is provided that correlates runway condition code to runway surface condition description and reported braking action that can then be used to determine the appropriate Normal Configuration Landing Distance or Non-Normal Configuration Landing Distance.

Normal Configuration Landing Distance

Tables are provided as advisory information for normal configuration landing distances on dry runways and runways with good, good to medium, medium, medium to poor, and poor reported braking action. Landing distances (reference distances plus adjustments) are 115% of the actual landing distance. The Normal Configuration Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

The reference landing distance is the distance from threshold to complete stop. It includes an air distance allowance from threshold to touchdown associated with a flare time of 7 seconds. The reference distance is based on a reference landing weight and speed at sea level, standard day, zero wind, zero slope, two engine detent No. 2 reverse thrust, and auto or manual speedbrakes.

To use these tables, determine the reference landing distance for the selected braking configuration and reported braking action. Adjust this reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers. Each correction is applied independently to the reference landing distance.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" reported braking action, the airplane may not be able to achieve these deceleration rates. In these cases, runway slope and inoperative reversers influence the stopping distance. It cannot be determined quickly when this will become a factor, therefore it is appropriate to add the effects of slope and inoperative reversers when using the autobrake system.

Non-Normal Configuration Landing Distance

Advisory information is provided to support non-normal configurations that affect landing. Landing distances and adjustments are provided for dry runways and runways with good, good-to-medium, medium, medium-to-poor, and poor reported braking action. Landing distances (reference distances plus adjustments) are representative of the actual landing distance, and are not factored. The Non-Normal Configuration Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

The reference landing distance is the distance from threshold to complete stop. It includes an air distance allowance from threshold to touchdown associated with a flare time of 7 seconds. The reference distance is based on a reference landing weight and speed at sea level, standard day, zero wind, zero slope, and maximum available reverse thrust.

Tables for Non-Normal Configuration Landing Distance in this section are similar in format and used in the same manner as tables for the Normal Configuration Landing Distance previously described.

For an engine inoperative landing, check the rate of climb capability shown in Gear Down Landing Rate of Climb Available tables to ensure adequate climb performance.

Recommended Brake Cooling Schedule

Advisory information is provided to assist in avoiding problems associated with hot brakes. For normal operation, most landings are at weights below the AFM quick turnaround limit weight.

Use of the recommended cooling schedule will help avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Enter the Reference Brake Energy table (Table 1) with the airplane weight and brakes on speed, adjusted for wind, at the appropriate temperature and altitude condition. Instructions for applying wind adjustments are included below the table. Linear interpolation may be used to obtain intermediate values. The resulting number is the reference brake energy per brake in millions of foot-pounds, and represents the amount of energy absorbed by each brake during a rejected takeoff.

To determine the energy per brake absorbed during landing, enter the Event Adjusted Brake Energy table (Table 2) for no reverse thrust or 2 engine reverse thrust with the reference brake energy per brake and the type of braking used during landing (Max Manual, Max Auto, or Autobrake). The resulting number is the adjusted brake energy per brake and represents the energy absorbed in each brake during the landing. The recommended cooling time is found in the final table (Table 3) by entering with the adjusted brake energy per brake. Times are provided for ground cooling and inflight gear down cooling.

Brake Temperature Monitor System (BTMS) indications are also shown. If brake cooling is determined from the BTMS, use the hottest brake indication 10 to 15 minutes after the airplane has come to a complete stop, or inflight with gear retracted to determine recommended cooling schedule.

Engine Inoperative

Initial Max Continuous %N1

The Initial Max Continuous %N1 setting for use following an engine failure is shown. The table is based on the typical all engine cruise speed of .79 Mach to provide a target %N1 setting at the start of driftdown. Once driftdown is established, the Max Continuous %N1 table should be used to determine %N1 for the given conditions.

Max Continuous %N1

Power setting is based on one engine operating with one A/C pack operating and all anti-ice bleeds off. Enter the table with pressure altitude, TAT, and IAS or Mach to read %N1. Power settings may be interpolated for intermediate airspeeds. %N1 bleed corrections are provided per pressure altitude.

It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating. The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously.

Driftdown Speed/Level Off Altitude

The table shows optimum driftdown speed as a function of cruise weight at start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off considering 100 ft/min residual rate of climb.

The level off altitude is dependent on air temperature (ISA deviation).

Driftdown/LRC Cruise Range Capability

This table shows the range capability from the start of driftdown. Driftdown is continued to level off altitude. As weight decreases due to fuel burn, the airplane is accelerated to long range cruise speed. Cruise is continued at level off altitude and long range cruise speed.

To determine fuel required, enter the Ground to Air Miles Conversion table (Table 1) with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Then enter the Driftdown/Cruise Fuel and Time table (Table 2) with air distance and weight at start of driftdown to determine fuel and time required. If altitudes other than the level off altitude is used, fuel and time required may be obtained by using the Engine Inoperative Long Range Cruise Diversion Fuel and Time table.

Long Range Cruise Altitude Capability

The table shows the maximum altitude that can be maintained at a given weight and air temperature (ISA deviation), based on LRC speed, Max Continuous thrust, and 100 ft/min residual rate of climb.

Long Range Cruise Control

The table provides target %N1, engine inoperative Long Range Cruise Mach number, IAS and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect single engine fuel burn.

APU Operation During Flight

For APU operation during flight, increase fuel flow according to the following table. These increments include the APU fuel flow and the effect of increased drag from the APU door.

PRESSURE ALTITUDE (1000 FT)	APU FUEL FLOW (KG/HR)
39	45
35	45
31	50
25	60
20	65
15	75
10	85
5	95

Long Range Cruise Diversion Fuel and Time

Tables are provided for crews to determine the fuel and time required to proceed to an alternate airfield with one engine inoperative. The data is based on single engine Long Range Cruise speed and .78/280/250 descent.

To determine the remaining fuel and time required, first enter the Ground to Air Miles Conversion table (Table 1) to convert ground distance and enroute wind to an equivalent still air distance. Next, enter the Reference Fuel and Time table (Table 2) with air distance from Table 1 and the desired altitude and read reference fuel and time required. Lastly, enter the Fuel Required Adjustment table (Table 3) with the reference fuel and the actual weight at checkpoint to obtain fuel required to destination.

Holding

Single engine holding data is provided in the same format as the all engine holding data and is based on the same assumptions.

Gear Down Landing Rate of Climb Available

Rate of climb data is provided as guidance information in the event an engine inoperative landing (manual or autoland) is planned. The tables show gear down rate of climb available for Flaps 15 and Flaps 30. Enter the table with TAT and pressure altitude to read rate of climb available. Apply adjustments shown to correct for weight.

Alternate Mode EEC

Introduction

This section contains performance data for airplane operation with the Electronic Engine Control (EEC) in the alternate mode (ALTN EEC switch illuminated) for applicable thrust ratings. The data includes engine bleed effects for normal air conditioning operation i.e., two packs on at normal flow all engines operating.

Operation with assumed temperature reduced thrust is not permitted with the EEC in the alternate mode.

Limit Weight

A simplified method which conservatively accounts for the effects of EEC in the ALTERNATE mode is to reduce the normal mode performance limited weights. The Limit Weight table provides takeoff field, climb, obstacle, tire speed and brake energy weights. No adjustment is necessary for weight limits not shown. To determine limit weights for operations with the EEC in the ALTERNATE mode, enter the table with each of the limit weights for normal mode EEC operation and read the associated limit weight for each performance condition. The most limiting of the takeoff weights must be used.

Derated or reduced takeoff thrust takeoffs are not allowed with the EEC in the ALTERNATE mode. Adjustments to the limit weights provided in this section are not valid for takeoffs using improved climb. Likewise, adjustments to the limit weights are not valid for takeoffs with a contaminated runway. Analysis from the Airplane Flight Manual - Digital Performance Information may yield less restrictive limit weights.

Takeoff Speed Adjustment

Takeoff speeds computed for the reduced weight need no further adjustment.

Max Takeoff %N1

To find alternate mode EEC Max Takeoff %N1 based on normal engine bleed for air conditioning packs on, enter the Alternate Mode EEC Max Takeoff %N1 table with airport pressure altitude and airport OAT and read %N1. Apply %N1 adjustments as provided when applicable.

Max Climb %N1

To find alternate mode EEC Max Climb %N1 based on normal engine bleed for air conditioning packs on, enter the Alternate Mode EEC Max Climb %N1 table with airport pressure altitude and TAT and read %N1. Apply %N1 adjustments as provided when applicable.

Go-Around %N1

Go-Around power setting for ALTERNATE MODE EEC operation is presented for bleed packs on (AUTO) and anti-ice off. Go-Around %N1 may be read directly from the tables for the desired pressure altitude and airport OAT.

The ALTERNATE MODE EEC schedule provides equal or greater thrust than the normal mode for the same lever position. Thrust protection is not provided in the ALTERNATE mode and maximum rated thrust is reached at a thrust lever position less than full forward. As a result, thrust overboost can occur at full forward thrust lever positions.

Alternate Mode EEC, Engine Inoperative

Initial Max Continuous %N1

Initial Max Continuous %N1 settings for use following an engine failure are presented. The table is based on the typical all engine cruise speed of .79 Mach to provide a target %N1 setting at the start of driftdown. Once driftdown is established, the Max Continuous %N1 table should be used to determine %N1 for the given conditions.

Max Continuous %N1

Power setting is based on one engine operating with one A/C pack operating and all anti-ice bleeds off. Enter the table with pressure altitude, TAT, and IAS or Mach to read %N1. Power settings may be interpolated for intermediate airspeeds. %N1 bleed corrections are provided per pressure altitude.

It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating. The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously.

Gear Down

This section contains performance for airplane operation with the landing gear extended for all phases of flight.

Note: The Flight Management System (FMS) does not contain special provisions for operation with landing gear extended. As a result, the FMS will generate inaccurate enroute speed schedules, display non-conservative predictions of fuel burn, estimated time of arrival (ETA), maximum altitude, and compute overly shallow descent path. An accurate estimated time of arrival is available if current speed or Mach is entered into the VNAV cruise page. Estimates of fuel remaining at waypoints or the destination may be computed by the crew based on current fuel flow indications, but should be updated frequently.

Tables for gear down performance in this section are identical in format and used in the same manner as tables for the gear up configuration previously described.

Gear Down, Engine Inoperative

This section contains performance for airplane operation with the landing gear extended for use following an engine failure.

The caution provided in the Gear Down section for use of the FMS in a gear down situation is still applicable.

Tables for gear down, engine inoperative performance in this section are identical in format and used in the same manner as tables for the gear up, engine inoperative configuration previously described.

Performance Inflight — Chapter PI
Table of Contents — Section 30

737-8 TS2 LEAP-1B28 KG C M FAA CATB TO1-10% TO2-20% ALT-AB (FMC Model 737-8.2) AOA-DIAL

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Performance Inflight — Chapter PI
Pkg Model Identification — Section 30

General

Performance Inflight number 30 package was chosen to represent all 737 MAX 8 28K CATB from GOL’s fleet.

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Performance Inflight — Chapter PI
General — Section 30

Flight Crew Requirements for Chemical Passenger Oxygen System
Required Pressure (PSI) for 114/115 Cubic Ft. Cylinder

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	4
50	122	530	735	945
45	113	520	725	930
40	104	510	715	915
35	95	505	700	900
30	86	495	690	885
25	77	485	680	870
20	68	480	670	860
15	59	470	655	840
10	50	460	645	830
5	41	455	635	815
0	32	445	620	800
-5	23	440	610	785
-10	14	430	600	770

V1 (MCG)
Max Takeoff Thrust

Temperature		PRESSURE ALTITUDE (FT)		
°C	°F	0	2000	4000
40	104	106	101	97
30	86	112	108	103
20	68	112	110	107
-60	-76	113	111	107

Takeoff Speeds - Dry Runway
Max Takeoff Thrust
Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
90	164	168	174	158	160	166	155	157	163	153	153	159			
85	159	162	170	153	155	162	150	152	159	148	149	156	145	146	152
80	155	157	166	149	150	158	146	147	155	144	144	152	141	141	148
75	150	151	161	143	145	154	140	142	151	138	139	148	135	136	144
70	144	145	157	137	139	150	134	136	147	132	133	143	129	130	140
65	138	139	152	132	133	145	129	130	142	127	128	139	124	125	136
60	131	132	147	125	127	140	122	124	137	120	121	134	118	119	131
55	124	125	141	118	120	135	116	117	132	114	115	129	111	112	126
50	116	118	135	111	113	129	109	110	126	107	108	124	105	105	121
45	109	110	129	104	105	123	101	103	121	100	101	118	98	98	116
40	101	102	123	96	98	117	93	95	115	92	93	113	90	91	110

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	6	6	6	8	8	8	9	11	13	5	6	6	7	7	7	9	10	11	-2	-2	-2	-3	-3	-3	-4	-4	-4
50	4	5	6	8	8	8	9	11	13	3	4	6	7	7	7	9	10	11	-1	-2	-2	-3	-3	-3	-4	-4	-4
40	1	2	4	6	7	8	9	11	13	1	2	4	5	6	7	9	10	11	0	-1	-1	-2	-2	-3	-4	-4	-4
30	0	0	1	3	5	7	8	11	13	0	0	2	3	5	6	7	9	11	0	0	0	-1	-2	-2	-3	-3	-4
20	0	0	1	2	3	5	6	9	11	0	0	1	2	3	5	6	8	10	0	0	0	0	-1	-1	-2	-3	-4
10	0	0	1	2	3	4	5	7	10	0	0	1	2	3	4	5	7	9	0	0	0	0	-1	-1	-2	-2	-3
0	0	0	1	2	3	4	5	6	8	0	0	1	2	3	4	5	6	8	0	0	0	0	-1	-1	-2	-2	-3
-60	3	2	3	4	4	5	6	7	9	0	0	1	2	3	4	5	6	8	0	0	0	0	-1	-1	-2	-2	-3

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
90	-3	-2	0	2	4	-3	-2	-1	0	1	2
80	-3	-1	0	2	3	-2	-1	-1	0	1	2
70	-2	-1	0	1	2	-2	-1	-1	0	1	2
60	-2	-1	0	1	2	-2	-1	-1	0	1	2
50	-1	-1	0	1	1	-2	-1	-1	0	1	2
40	-1	-1	0	1	1	-2	-2	-1	0	1	2

***V1 not to exceed VR.**

Takeoff Speeds - Dry Runway
Max Takeoff Thrust
Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	99	96	95	93	92	90	87	83	78
55	99	96	95	93	92	90	87	83	78
50	102	99	95	93	92	90	87	83	78
45	105	102	98	94	92	90	87	83	78
40	109	106	101	97	93	90	87	83	78
35	112	109	105	100	96	91	87	83	78
30	113	112	108	103	98	94	89	84	78
25	113	112	110	105	100	96	91	86	79
20	113	112	110	107	103	98	94	88	81
15	113	112	110	107	103	100	96	90	83
10	113	112	110	107	103	100	97	92	85
5	113	113	110	107	103	100	97	93	87
0	113	113	110	107	104	100	97	93	89
-60	114	113	111	107	104	101	98	94	89

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Takeoff Speeds - Wet Runway

Max Takeoff Thrust

Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
90	157	168	174	150	160	166	147	157	163	144	153	159			
85	151	162	170	144	155	162	141	152	159	139	149	156	136	146	152
80	145	157	166	139	150	158	136	147	155	133	144	152	130	141	148
75	139	151	161	133	145	154	130	142	151	127	139	148	125	136	144
70	133	145	157	127	139	150	124	136	147	121	133	143	119	130	140
65	126	139	152	121	133	145	118	130	142	116	128	139	113	125	136
60	120	132	147	114	127	140	112	124	137	109	121	134	107	119	131
55	112	125	141	108	120	135	105	117	132	103	115	129	101	112	126
50	105	118	135	100	113	129	98	110	126	96	108	124	94	105	121
45	97	110	129	93	105	123	90	103	121	88	101	118	86	98	116
40	89	102	123	85	98	117	83	95	115	81	93	113	79	91	110

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	9	9	9	10	10	10	11	13	16	5	6	6	7	7	7	9	10	11	-2	-2	-2	-3	-3	-3	-4	-4	-4
50	5	6	8	10	10	10	11	13	16	3	4	6	7	7	7	9	10	11	-1	-2	-2	-3	-3	-3	-4	-4	-4
40	1	3	5	6	8	10	11	13	16	1	2	4	5	6	7	9	10	11	0	-1	-1	-2	-2	-3	-4	-4	-4
30	0	0	1	3	6	8	10	13	16	0	0	2	3	5	6	7	9	11	0	0	0	-1	-2	-2	-3	-3	-4
20	0	0	1	1	3	5	7	10	14	0	0	1	2	3	5	6	8	10	0	0	0	0	-1	-1	-2	-3	-4
10	0	0	1	1	3	4	5	8	12	0	0	1	2	3	4	5	7	9	0	0	0	0	-1	-1	-2	-2	-3
0	0	0	1	1	3	4	5	7	9	0	0	1	2	3	4	5	6	8	0	0	0	0	-1	-1	-2	-2	-3
-60	2	2	2	3	5	6	7	9	11	0	0	1	2	3	4	5	6	8	0	0	0	0	-1	-1	-2	-2	-3

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
90	-5	-3	0	3	6	-4	-2	-1	0	1	3
80	-4	-2	0	2	5	-4	-3	-1	0	1	3
70	-4	-2	0	1	4	-4	-3	-1	0	1	3
60	-3	-2	0	1	3	-4	-3	-1	0	1	3
50	-3	-1	0	1	3	-4	-3	-1	0	1	3
40	-3	-1	0	1	2	-4	-3	-1	0	1	3

***V1 not to exceed VR.**

Takeoff Speeds - Wet Runway
Max Takeoff Thrust
Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	99	96	95	93	92	90	87	83	78
55	99	96	95	93	92	90	87	83	78
50	102	99	95	93	92	90	87	83	78
45	105	102	98	94	92	90	87	83	78
40	109	106	101	97	93	90	87	83	78
35	112	109	105	100	96	91	87	83	78
30	113	112	108	103	98	94	89	84	78
25	113	112	110	105	100	96	91	86	79
20	113	112	110	107	103	98	94	88	81
15	113	112	110	107	103	100	96	90	83
10	113	112	110	107	103	100	97	92	85
5	113	113	110	107	103	100	97	93	87
0	113	113	110	107	104	100	97	93	89
-60	114	113	111	107	104	101	98	94	89

Stabilizer Trim Setting

Max Takeoff Thrust

Flaps 1 and 5

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/4	8	7 3/4	7 1/4	7	6 3/4	6 1/4	6	5 1/2	5 1/4	4 3/4	4 1/2	4	3 3/4	3 1/4
80	8 1/2	8 1/4	8	7 1/2	7 1/4	7	6 1/2	6 1/4	5 3/4	5 1/2	5	4 3/4	4 1/4	4	3 1/2	3 1/4
70	8	7 3/4	7 1/2	7	6 3/4	6 1/2	6	5 3/4	5 1/2	5	4 3/4	4 1/4	4	3 1/2	3 1/4	3
60	7 1/4	7	6 3/4	6 1/2	6 1/4	5 3/4	5 1/2	5 1/4	4 3/4	4 1/2	4	3 3/4	3 1/2	3	3	3
50	6 1/4	6	5 3/4	5 1/2	5 1/4	5	4 3/4	4 1/4	4	3 3/4	3 1/4	3	3	3	3	3
40	5	4 3/4	4 1/2	4 1/4	4	3 3/4	3 1/2	3 1/4	3	3	3	3	3	3	3	3

Flaps 10, 15, and 25

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8	7 1/2	6 3/4	6 1/4	5 3/4	5 1/2	5	4 1/2	4 1/4	3 3/4	3 1/4	3	3	3
80	8 1/2	8 1/2	8	7 1/4	6 3/4	6 1/4	5 3/4	5 1/4	5	4 1/2	4	3 1/2	3 1/4	3	3	3
70	8 1/2	8	7 1/4	6 3/4	6	5 1/2	5 1/4	4 3/4	4 1/2	4	3 1/2	3 1/4	3	3	3	3
60	7 3/4	7 1/4	6 1/2	6	5 1/2	5	4 1/2	4 1/4	3 3/4	3 1/4	3	3	3	3	3	3
50	6	5 1/2	5 1/4	4 3/4	4 1/4	4	3 1/2	3 1/4	3	3	3	3	3	3	3	3
40	4 1/4	4	3 3/4	3 1/2	3 1/4	3	3	3	3	3	3	3	3	3	3	3

VREF

Based on 14500 ft reference pressure altitude

WEIGHT (1000 KG)	VREF (KIAS) FLAPS		
	40	30	15
85	163	163	173
80	156	157	168
75	149	152	162
70	144	147	156
65	140	142	151
60	134	137	145
55	128	130	138
50	121	124	132
45	115	117	125
40	108	111	118

Flap Maneuver Speeds

FLAP POSITION	MANEUVER SPEED
UP	VREF40 + 70
1	VREF40 + 50
5	VREF40 + 30
10	VREF40 + 30
15	VREF40 + 20
25	VREF40 + 10
30	VREF30
40	VREF40

ADVISORY INFORMATION

Slush/Standing Water Takeoff

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5.7	-7.2	-8.8	-10.1	-7.8	-9.4	-10.9	-12.3	-11.9	-13.4	-15.0	-16.3
80	-5.1	-6.6	-8.1	-9.5	-6.7	-8.3	-9.8	-11.1	-9.8	-11.2	-12.8	-14.2
70	-4.1	-5.7	-7.2	-8.5	-5.3	-6.8	-8.3	-9.7	-7.4	-8.9	-10.4	-11.8
60	-2.9	-4.4	-5.9	-7.3	-3.6	-5.1	-6.6	-8.0	-4.9	-6.4	-7.9	-9.3
50	-1.3	-2.8	-4.3	-5.7	-1.6	-3.1	-4.6	-6.0	-2.2	-3.7	-5.2	-6.6
40	0.0	-1.5	-3.0	-4.4	0.0	-1.5	-3.0	-4.4	0.0	-1.5	-3.0	-4.4

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	30.9				33.6				38.7			
1400	54.5	32.7			56.8	35.4			60.4	40.2		
1600	78.7	56.1	34.2		80.2	58.4	37.0		82.4	62.0	41.7	23.7
1800	103.6	80.4	57.9	38.1	104.3	81.9	60.0	40.7	104.7	84.0	63.5	45.3
2000		105.2	82.1	61.7		105.8	83.6	63.8		106.2	85.5	67.0
2200			107.2	86.2			107.6	87.5			107.8	89.2
2400				111.1				111.4				111.4

1. **Enter Table 1 with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-14	-9	-4	0	-11	-6	-1	0	-3	0	0	0
80	-15	-10	-5	-1	-13	-8	-3	0	-5	0	0	0
70	-17	-12	-7	-2	-14	-9	-4	0	-8	-3	0	0
60	-18	-13	-8	-4	-17	-12	-7	-2	-12	-7	-2	0
50	-21	-16	-11	-6	-19	-14	-9	-5	-16	-11	-6	-1
40	-24	-19	-14	-9	-23	-18	-13	-9	-21	-16	-11	-7

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-7.9	-9.4	-11.0	-12.4	-10.3	-11.8	-13.3	-14.7	-14.6	-16.1	-17.7	-19.1
80	-7.3	-8.8	-10.3	-11.7	-9.0	-10.6	-12.1	-13.5	-12.2	-13.7	-15.2	-16.6
70	-6.2	-7.7	-9.3	-10.7	-7.4	-9.0	-10.5	-11.9	-9.6	-11.1	-12.7	-14.0
60	-4.7	-6.3	-7.8	-9.2	-5.5	-7.1	-8.6	-10.0	-6.8	-8.3	-9.9	-11.2
50	-2.9	-4.4	-5.9	-7.3	-3.3	-4.8	-6.4	-7.8	-3.9	-5.4	-7.0	-8.4
40	-0.6	-2.2	-3.7	-5.1	-0.7	-2.2	-3.8	-5.2	-0.9	-2.4	-3.9	-5.3

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1400									22.4			
1600	19.5				34.8				52.8	24.8		
1800	65.5	23.5			72.7	38.5	0.3		81.3	55.6	28.2	
2000	100.5	69.3	28.4		103.5	75.9	42.6	9.8	107.8	83.8	58.4	33.4
2200		104.5	72.6	37.2		106.7	78.7	49.6		109.8	86.2	63.7
2400			106.5	79.5			109.0	84.7			112.7	91.1
2600				113.4				114.8				

1. **Enter Table 1 with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -35 m/+35 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-19	-14	-9	-5	-15	-10	-5	0	-5	0	0	0
80	-21	-16	-11	-7	-17	-12	-7	-3	-8	-3	0	0
70	-24	-19	-14	-9	-20	-15	-10	-6	-12	-7	-2	0
60	-26	-21	-16	-12	-24	-19	-14	-9	-17	-12	-7	-3
50	-30	-25	-20	-15	-28	-23	-18	-13	-23	-18	-13	-9
40	-33	-28	-23	-19	-32	-27	-22	-18	-30	-25	-20	-15

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

ADVISORY INFORMATION

Dry Snow Takeoff

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4.4	-5.7	-7.1	-8.3	-6.0	-7.3	-8.7	-9.9	-9.2	-10.5	-11.9	-13.1
80	-4.4	-5.7	-7.1	-8.3	-5.6	-7.0	-8.3	-9.6	-8.0	-9.3	-10.7	-11.9
70	-3.9	-5.2	-6.6	-7.8	-4.8	-6.2	-7.5	-8.8	-6.5	-7.8	-9.2	-10.4
60	-2.9	-4.3	-5.6	-6.8	-3.5	-4.9	-6.3	-7.5	-4.6	-6.0	-7.3	-8.6
50	-1.5	-2.8	-4.2	-5.4	-1.8	-3.1	-4.5	-5.7	-2.4	-3.8	-5.1	-6.4
40	0.0	-1.4	-2.7	-3.9	0.0	-1.4	-2.7	-3.9	0.0	-1.2	-2.6	-3.8

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	34.8				38.8				43.4	25.4		
1400	59.2	37.9			61.8	41.7	21.7		64.4	46.0	27.8	
1600	84.0	62.3	40.9	21.9	85.2	64.7	44.5	26.5	86.0	67.1	48.6	32.3
1800	109.0	87.0	65.4	46.0	108.8	88.1	67.5	49.3	107.9	88.7	69.7	53.0
2000		112.1	90.1	70.6		111.9	91.1	72.4		110.8	91.5	74.2
2200				95.4				96.1				96.1

1. **Enter Table 1 with dry snow depth and dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-10	-5	0	0	-8	-3	0	0	-3	0	0	0
80	-13	-8	-3	0	-10	-5	0	0	-5	0	0	0
70	-15	-10	-5	-1	-13	-8	-3	0	-8	-3	0	0
60	-18	-13	-8	-3	-15	-10	-5	-1	-11	-6	-1	0
50	-20	-15	-10	-6	-18	-13	-8	-4	-14	-9	-4	0
40	-23	-18	-13	-9	-21	-16	-11	-7	-18	-13	-8	-3

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Dry Snow Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6.4	-7.5	-8.7	-9.8	-8.1	-9.3	-10.4	-11.5	-11.2	-12.4	-13.6	-14.6
80	-6.4	-7.6	-8.8	-9.9	-7.7	-8.9	-10.1	-11.2	-10.1	-11.2	-12.4	-13.5
70	-6.0	-7.2	-8.3	-9.4	-6.8	-8.0	-9.2	-10.3	-8.5	-9.7	-10.9	-12.0
60	-4.9	-6.1	-7.3	-8.3	-5.4	-6.6	-7.8	-8.9	-6.6	-7.8	-8.9	-10.0
50	-3.3	-4.4	-5.6	-6.7	-3.5	-4.7	-5.9	-6.9	-4.1	-5.3	-6.5	-7.6
40	-1.0	-2.2	-3.4	-4.4	-1.1	-2.3	-3.4	-4.5	-1.3	-2.4	-3.6	-4.7

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1400	0.4				23.0				40.5	18.8		
1600	46.0	6.6			57.3	28.7			66.1	44.5	22.7	
1800	83.9	52.7	15.6		87.8	62.4	33.8	7.0	91.1	69.9	48.4	29.0
2000	115.0	88.9	59.3	25.3	115.7	92.1	67.3	42.2		94.9	73.8	54.5
2200		121.8	93.5	68.2			96.4	74.5			98.8	79.8
2400				101.0				103.1				104.7

1. **Enter Table 1 with dry snow depth and dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-14	-9	-4	0	-10	-5	0	0	-4	0	0	0
80	-17	-12	-7	-3	-14	-9	-4	0	-7	-2	0	0
70	-21	-16	-11	-6	-18	-13	-8	-3	-11	-6	-1	0
60	-25	-20	-15	-10	-22	-17	-12	-7	-16	-11	-6	-1
50	-29	-24	-19	-15	-26	-21	-16	-11	-21	-16	-11	-6
40	-34	-29	-24	-19	-31	-26	-21	-16	-26	-21	-16	-11

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

ADVISORY INFORMATION

Wet Snow Takeoff

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4.3	-5.6	-6.9	-8.2	-6.0	-7.3	-8.7	-9.8	-11.1	-12.4	-13.7	-14.9
80	-4.4	-5.7	-7.0	-8.2	-5.7	-7.0	-8.3	-9.5	-9.5	-10.8	-12.1	-13.3
70	-3.9	-5.2	-6.5	-7.8	-4.9	-6.2	-7.5	-8.7	-7.5	-8.8	-10.2	-11.3
60	-2.9	-4.2	-5.5	-6.7	-3.5	-4.8	-6.1	-7.3	-5.1	-6.4	-7.8	-9.0
50	-1.4	-2.7	-4.0	-5.2	-1.6	-2.9	-4.2	-5.4	-2.4	-3.7	-5.0	-6.2
40	0.0	-1.3	-2.6	-3.8	0.0	-1.3	-2.6	-3.8	0.0	-1.3	-2.6	-3.8

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	33.0				35.6				40.5	21.7		
1400	57.7	36.3			59.6	38.8			62.5	43.4	24.5	
1600	83.0	61.0	39.5	20.2	84.0	62.8	41.9	23.2	84.8	65.4	46.3	29.3
1800	108.9	86.4	64.3	44.9	108.7	87.2	65.9	47.2	107.4	87.7	68.3	51.0
2000		112.3	89.8	69.8		111.9	90.4	71.3		110.3	90.7	73.1
2200			115.5	95.4				95.8				95.6

1. **Enter Table 1 with wet snow depth and dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-11	-6	-1	0	-8	-3	0	0	-2	0	0	0
80	-14	-9	-4	0	-11	-6	-1	0	-3	0	0	0
70	-16	-11	-6	-1	-13	-8	-3	0	-6	-1	0	0
60	-18	-13	-8	-4	-16	-11	-6	-2	-10	-5	0	0
50	-21	-16	-11	-7	-20	-15	-10	-5	-16	-11	-6	-1
40	-25	-20	-15	-11	-24	-19	-14	-10	-22	-17	-12	-8

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Wet Snow Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6.4	-7.7	-9.0	-10.2	-8.3	-9.5	-10.8	-12.0	-13.5	-14.8	-16.1	-17.3
80	-6.6	-7.9	-9.2	-10.3	-7.9	-9.2	-10.5	-11.6	-11.8	-13.1	-14.4	-15.6
70	-6.1	-7.4	-8.7	-9.8	-6.9	-8.3	-9.5	-10.7	-9.7	-11.0	-12.2	-13.4
60	-5.0	-6.3	-7.6	-8.8	-5.4	-6.8	-8.0	-9.2	-7.1	-8.4	-9.7	-10.9
50	-3.2	-4.5	-5.8	-7.0	-3.4	-4.7	-6.0	-7.2	-4.2	-5.5	-6.8	-7.9
40	-0.9	-2.1	-3.4	-4.6	-0.8	-2.1	-3.4	-4.5	-0.9	-2.2	-3.4	-4.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1400									29.6			
1500					26.4				45.8			
1600	37.8				48.3				61.1	35.2		
1700	61.8	22.6			67.9	33.8			75.4	51.0		
1800	81.4	46.3			84.7	55.5			88.9	66.1	40.6	
1900	98.0	69.4	29.0		99.7	74.2	41.6		101.8	80.1	56.4	32.6
2000		87.3	55.2	15.4		90.0	62.4	30.5		93.3	71.0	48.8
2100		103.1	75.5	42.7		105.8	79.6	52.3			84.6	63.8
2200			92.6	65.6			94.9	71.2			97.6	77.9
2300				84.4				87.5				91.2
2400				101.0				102.4				

1. **Enter Table 1 with wet snow depth and dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-14	-9	-4	0	-11	-6	-1	0	-3	0	0	0
80	-18	-13	-8	-4	-14	-9	-4	0	-4	0	0	0
70	-22	-17	-12	-7	-18	-13	-8	-4	-9	-4	0	0
60	-26	-21	-16	-11	-23	-18	-13	-9	-15	-10	-5	0
50	-31	-26	-21	-16	-29	-24	-19	-14	-23	-18	-13	-8
40	-37	-32	-27	-22	-35	-30	-25	-21	-32	-27	-22	-18

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

ADVISORY INFORMATION

Slippery Runway Takeoff

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-1.0	-1.8	-2.6	-3.3	-3.0	-3.9	-4.6	-5.4	-10.4	-11.2	-12.0	-12.7
80	-1.0	-1.9	-2.6	-3.4	-3.3	-4.1	-4.9	-5.6	-9.7	-10.5	-11.3	-12.0
70	-0.8	-1.5	-2.4	-3.0	-3.1	-3.9	-4.7	-5.4	-8.6	-9.3	-10.2	-10.8
60	-0.1	-0.9	-1.7	-2.4	-2.4	-3.2	-3.9	-4.7	-6.8	-7.7	-8.4	-9.2
50	0.0	-0.8	-1.6	-2.3	-1.2	-2.0	-2.8	-3.4	-4.6	-5.4	-6.2	-6.9
40	0.0	-0.8	-1.6	-2.3	0.0	-0.8	-1.6	-2.3	-1.9	-2.7	-3.5	-4.2

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	62.0	37.2	10.1		31.3							
1400	92.5	70.5	46.3	22.9	56.4	34.7						
1600		100.7	79.2	58.5	82.4	59.8	37.9	18.2				
1800			109.1	90.1	109.0	85.9	63.2	43.4				
2000						112.4	89.3	68.8	41.4			
2200							115.6	95.2	52.7	33.1		
2400									64.9	44.0		
2600									78.2	55.4	35.6	
2800									93.2	67.9	46.6	
3000										81.5	58.2	40.0
3200										96.9	70.9	51.2
3400											85.0	63.3
3600											100.0	76.4
3800												91.2

1. **Enter Table 1 with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -25 m/+25 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -30 m/+30 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -55 m/+55 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-9	-6	-4	-1	-13	-11	-8	-6	-34	-32	-29	-27
80	-10	-7	-5	-3	-15	-13	-10	-8	-38	-35	-33	-31
70	-11	-9	-6	-4	-18	-15	-13	-10	-41	-39	-36	-34
60	-12	-10	-7	-5	-20	-17	-15	-13	-44	-42	-39	-37
50	-13	-10	-8	-6	-22	-20	-17	-15	-46	-44	-41	-39
40	-14	-11	-9	-6	-25	-23	-20	-18	-48	-46	-43	-41

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Slippery Runway Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-2.5	-3.3	-4.1	-4.8	-5.0	-5.8	-6.6	-7.3	-14.1	-14.9	-15.7	-16.4
80	-2.5	-3.3	-4.1	-4.8	-5.4	-6.2	-7.0	-7.7	-13.4	-14.2	-15.0	-15.7
70	-2.1	-2.9	-3.7	-4.4	-5.2	-6.0	-6.8	-7.5	-11.8	-12.6	-13.4	-14.1
60	-1.3	-2.1	-2.9	-3.6	-4.4	-5.2	-5.9	-6.7	-9.4	-10.2	-11.0	-11.7
50	-0.1	-0.9	-1.7	-2.4	-2.9	-3.7	-4.5	-5.3	-6.1	-6.9	-7.7	-8.4
40	0.0	-0.8	-1.6	-2.3	-0.9	-1.7	-2.5	-3.2	-2.0	-2.8	-3.6	-4.3

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	22.4											
1300	52.0											
1400	76.9	37.3										
1500	94.4	67.7	20.2									
1600		87.6	57.1	8.7	28.5							
1700		104.0	80.1	48.7	57.6							
1800			97.5	74.4	79.0	38.6						
1900				92.9	96.7	65.3	18.1					
2000						85.1	48.3					
2100						102.0	72.1	32.8				
2200							90.8	61.1				
2300								81.7				
2400								99.0				
3800									69.8			
3900									87.6			
4000									100.5			
4200										74.7		
4300										90.4		
4600											78.6	
4700											93.5	

1. **Enter Table 1 with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -25 m/+25 m for every 10°C above/below 0°C.
   Adjust "Medium" field length available by -30 m/+30 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -80 m/+80 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Slippery Runway Takeoff
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-12	-7	-2	0	-17	-12	-7	-3	-53	-48	-43	-38
80	-13	-8	-3	0	-21	-16	-11	-6	-59	-54	-49	-45
70	-15	-10	-5	0	-24	-19	-14	-10	-66	-61	-56	-51
60	-16	-11	-6	-2	-28	-23	-18	-13	-71	-66	-61	-57
50	-17	-12	-7	-3	-32	-27	-22	-18	-76	-71	-66	-61
40	-18	-13	-8	-4	-37	-32	-27	-22	-80	-75	-70	-65

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

Takeoff %N1

Max Takeoff Thrust

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	85.2	85.7	86.2	86.2	86.3	86.3	86.3	86.3	86.3	86.3	86.1	85.7	85.3	84.4	83.4	82.3	81.1	80.5
55	86.7	87.1	87.5	87.5	87.6	87.6	87.6	87.6	87.6	87.6	87.4	87.0	86.7	85.7	84.8	83.6	82.5	81.9
50	88.2	88.6	89.0	88.9	88.9	88.9	88.9	88.9	88.9	88.9	88.7	88.3	87.9	87.0	86.1	84.9	83.8	83.2
45	89.6	90.0	90.4	90.4	90.3	90.3	90.2	90.1	90.1	90.2	89.9	89.5	89.2	88.3	87.3	86.2	85.1	84.5
40	90.9	91.4	91.8	91.8	91.7	91.7	91.6	91.5	91.4	91.3	91.1	90.8	90.4	89.5	88.6	87.4	86.3	85.7
35	92.2	92.7	93.2	93.2	93.1	93.0	92.8	92.7	92.5	92.2	92.0	91.8	91.6	90.6	89.7	88.6	87.6	87.0
30	91.8	93.2	94.5	94.3	94.3	94.1	93.9	93.7	93.4	93.1	92.8	92.6	92.4	91.6	90.8	89.8	88.8	88.3
25	91.0	92.3	93.6	94.2	94.8	95.0	94.8	94.6	94.3	94.0	93.7	93.5	93.3	92.5	91.7	90.8	89.9	89.5
20	90.2	91.5	92.8	93.3	93.9	94.5	94.9	95.3	95.1	94.8	94.4	94.2	94.2	93.4	92.6	91.7	90.9	90.5
15	89.4	90.7	91.9	92.5	93.0	93.6	94.1	94.5	94.9	95.2	95.5	95.3	94.9	94.0	93.2	92.5	91.7	91.3
10	88.6	89.9	91.1	91.6	92.2	92.8	93.3	93.7	94.0	94.4	95.0	95.7	96.3	95.3	94.1	93.1	92.3	92.0
5	87.8	89.0	90.3	90.8	91.4	92.0	92.5	92.8	93.2	93.5	94.1	94.9	95.5	95.3	95.2	94.8	93.7	93.1
0	86.9	88.2	89.5	90.0	90.6	91.1	91.6	91.9	92.3	92.7	93.3	94.1	94.6	94.5	94.3	94.2	94.2	94.2
-5	86.1	87.4	88.6	89.2	89.7	90.3	90.7	91.1	91.4	91.8	92.4	93.2	93.7	93.6	93.5	93.4	93.3	93.3
-10	85.2	86.5	87.8	88.3	88.9	89.4	89.9	90.2	90.5	90.9	91.5	92.3	92.9	92.8	92.6	92.5	92.5	92.4
-15	84.4	85.7	87.0	87.5	88.1	88.5	89.0	89.3	89.7	90.1	90.7	91.5	92.1	91.9	91.8	91.7	91.6	91.6
-20	83.6	84.9	86.1	86.6	87.2	87.7	88.1	88.4	88.8	89.2	89.8	90.6	91.2	91.1	90.9	90.8	90.8	90.7
-25	82.8	84.0	85.3	85.8	86.4	86.8	87.3	87.6	87.9	88.3	89.0	89.8	90.3	90.2	90.1	90.0	89.9	89.9
-30	82.0	83.2	84.4	84.9	85.5	86.0	86.4	86.7	87.0	87.4	88.1	88.9	89.5	89.4	89.2	89.1	89.1	89.0
-35	81.1	82.3	83.6	84.1	84.7	85.1	85.5	85.8	86.2	86.6	87.2	88.0	88.5	88.5	88.3	88.3	88.2	88.2
-40	80.3	81.5	82.7	83.2	83.8	84.2	84.6	84.9	85.3	85.7	86.3	87.1	87.6	87.5	87.4	87.4	87.3	87.3
-45	79.4	80.6	81.8	82.3	82.9	83.3	83.7	84.0	84.4	84.8	85.4	86.1	86.7	86.6	86.5	86.5	86.4	86.4
-50	78.6	79.7	80.9	81.4	82.0	82.4	82.8	83.1	83.4	83.9	84.4	85.2	85.7	85.7	85.6	85.6	85.5	85.5

%N1 Adjustment for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.7	0.8	0.8	0.9	1.0	0.9	1.0	1.0	1.1	1.2	1.4	1.4	1.6	1.8	2.0	2.0	2.0	2.1
ENGINE ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.9	-0.9	-0.9	-0.8	-0.9	-0.9

Assumed Temperature Reduced Thrust

Maximum Assumed Temperature (Table 1 of 3)

Based on 25% Takeoff Thrust Reduction

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	84	84	84	84	84	84	84	84	84									
55	79	79	80	80	80	80	80	80	80	80	80	80						
50	74	74	74	75	75	75	75	75	75	75	75	75	75	75				
45	69	69	69	69	70	70	71	71	71	71	71	71	71	70	70	70	69	
40	64	64	64	64	65	65	65	66	66	66	66	66	66	66	66	65	65	65
35	59	59	59	59	59	60	60	61	61	62	62	61	61	61	61	61	60	60
30	58	56	54	54	54	56	56	57	57	58	58	57	57	56	56	56	56	56
25	58	56	54	53	52	51	52	52	53	53	53	53	53	52	52	52	51	51
20	58	56	54	53	52	51	49	49	49	49	49	49	49	48	48	47	47	47
15	58	57	54	53	52	51	49	49	48	47	45	44	44	44	43	43	42	42
10	58	57	54	53	52	51	49	49	48	46	44	43	41	39	38	38	38	37
5	59	57	54	53	52	51	50	49	48	46	44	43	41	38	35	33	32	32
0	59	57	54	53	52	51	50	49	48	46	44	43	41	38	35	33	31	29
-5 & BELOW	59	57	54	53	52	51	50	49	48	46	44	43	41	38	35	33	31	29

Takeoff %N1 (Table 2 of 3)

Based on engine bleed for packs on and engine anti-ice off

ASSUMED TEMP (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
75	81.1	81.6	82.0	82.1	82.2	82.2	82.2	82.2	82.2	82.2	82.0	81.6	81.2	80.2	79.4	79.0	78.6	78.4
70	82.5	83.0	83.5	83.5	83.6	83.6	83.6	83.6	83.6	83.6	83.4	83.0	82.6	81.6	80.7	79.5	78.3	77.9
65	83.9	84.4	84.8	84.9	85.0	85.0	84.9	85.0	85.0	85.0	84.7	84.4	84.0	83.0	82.1	80.9	79.7	79.1
60	85.2	85.7	86.2	86.2	86.3	86.3	86.3	86.3	86.3	86.3	86.1	85.7	85.3	84.4	83.4	82.3	81.1	80.5
55	86.7	87.1	87.5	87.5	87.6	87.6	87.6	87.6	87.6	87.6	87.4	87.0	86.7	85.7	84.8	83.6	82.5	81.9
50	88.2	88.6	89.0	88.9	88.9	88.9	88.9	88.9	88.9	88.9	88.7	88.3	87.9	87.0	86.1	84.9	83.8	83.2
45	89.6	90.0	90.4	90.4	90.3	90.3	90.2	90.1	90.1	90.2	89.9	89.5	89.2	88.3	87.3	86.2	85.1	84.5
40	90.9	91.4	91.8	91.8	91.7	91.7	91.6	91.5	91.4	91.3	91.1	90.8	90.4	89.5	88.6	87.4	86.3	85.7
35	92.2	92.7	93.2	93.2	93.1	93.0	92.8	92.7	92.5	92.2	92.0	91.8	91.6	90.6	89.7	88.6	87.6	87.0
30	91.8	93.2	94.5	94.3	94.3	94.1	93.9	93.7	93.4	93.1	92.8	92.6	92.4	91.6	90.8	89.8	88.8	88.3
25	91.0	92.3	93.6	94.2	94.8	95.0	94.8	94.6	94.3	94.0	93.7	93.5	93.3	92.5	91.7	90.8	89.9	89.5
20	90.2	91.5	92.8	93.3	93.9	94.5	94.9	95.3	95.1	94.8	94.4	94.2	94.2	93.4	92.6	91.7	90.9	90.5
15	89.4	90.7	91.9	92.5	93.0	93.6	94.1	94.5	94.9	95.2	95.5	95.3	94.9	94.0	93.2	92.5	91.7	91.3
10	88.6	89.9	91.1	91.6	92.2	92.8	93.3	93.7	94.0	94.4	95.0	95.7	96.3	95.3	94.1	93.1	92.3	92.0
5	87.8	89.0	90.3	90.8	91.4	92.0	92.5	92.8	93.2	93.5	94.1	94.9	95.5	95.3	95.2	94.8	93.7	93.1
0	86.9	88.2	89.5	90.0	90.6	91.1	91.6	91.9	92.3	92.7	93.3	94.1	94.6	94.5	94.3	94.2	94.2	94.2
-5	86.1	87.4	88.6	89.2	89.7	90.3	90.7	91.1	91.4	91.8	92.4	93.2	93.7	93.6	93.5	93.4	93.3	93.3
-20	83.6	84.9	86.1	86.6	87.2	87.7	88.1	88.4	88.8	89.2	89.8	90.6	91.2	91.1	90.9	90.8	90.8	90.7
-40	80.3	81.5	82.7	83.2	83.8	84.2	84.6	84.9	85.3	85.7	86.3	87.1	87.6	87.5	87.4	87.4	87.3	87.3
MINIMUM ASSUMED TEMP (°C)	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	1

Assumed Temperature Reduced Thrust

%N1 Adjustment for Temperature Difference (Table 3 of 3)

ASSUMED TEMP MINUS OAT (°C)	OUTSIDE AIR TEMPERATURE (°C)													
	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
115	8.6													
110	8.6													
105	8.6													
100	8.6													
95	7.2	9.0												
90	5.4	9.0												
85	3.6	9.0												
80	1.8	9.0												
75	0.1	7.5	9.4											
70	0.0	5.6	9.4	9.3										
65	0.0	3.7	8.8	8.7	8.7									
60	0.0	1.9	8.2	8.2	8.1	8.1								
55	0.0	0.1	7.6	7.6	7.5	7.5	7.4							
50	0.0	0.0	5.8	7.0	6.9	6.9	6.8	6.6						
45	0.0	0.0	3.9	5.9	6.3	6.3	6.2	6.0	5.8					
40	0.0	0.0	2.0	4.0	5.7	5.6	5.6	5.4	5.3	5.1				
35		0.0	0.1	2.0	4.0	5.0	4.9	4.8	4.6	4.5	4.4			
30		0.0	0.0	0.1	2.1	4.1	4.3	4.2	4.0	3.9	3.8	3.7		
25		0.0	0.0	0.0	0.2	2.2	3.6	3.5	3.4	3.3	3.2	3.1	3.0	
20		0.0	0.0	0.0	0.0	0.2	2.2	2.8	2.7	2.7	2.6	2.5	2.4	2.4
15			0.0	0.0	0.0	0.0	0.3	2.2	2.1	2.0	2.0	1.9	1.8	1.8
10			0.0	0.0	0.0	0.0	0.0	0.3	1.4	1.4	1.3	1.3	1.2	1.2
5			0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.7	0.6	0.6	0.6
0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1. **Determine Maximum Assumed Temperature allowed from Table 1.**
2. **Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).**
3. **Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.**
4. **Subtract %N1 adjustment from Maximum %N1 in Table 2.**

TO1 Takeoff Speeds - Dry Runway

10% Thrust Reduction

Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
85	163	164	169												
80	158	159	165	152	152	158	149	149	154						
75	153	154	160	146	147	153	143	144	150	141	141	147	137	138	144
70	147	148	156	140	141	149	137	138	146	135	135	143	132	132	140
65	140	142	151	134	135	144	131	132	141	129	130	138	126	127	136
60	134	135	146	128	129	139	125	126	136	123	123	133	120	121	131
55	127	128	140	121	122	134	118	119	131	116	117	128	114	114	126
50	119	120	134	114	115	128	111	112	126	109	110	123	107	107	121
45	111	112	128	106	107	122	104	105	120	102	103	117	100	100	115
40	103	104	121	98	100	116	96	97	114	95	95	111	92	93	109

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	6	7	7	8	8	8	9	10	10	5	6	6	6	7	7	8	8	10	-2	-2	-2	-3	-3	-3	-3	-4	-4
50	4	5	6	8	8	8	9	10	10	3	4	5	6	7	7	8	8	10	-1	-1	-2	-3	-3	-3	-3	-4	-4
40	1	3	4	5	7	8	9	10	10	1	2	3	5	6	7	8	8	10	0	-1	-1	-2	-2	-3	-3	-4	-4
30	0	0	1	3	5	6	8	10	10	0	0	1	3	4	6	7	8	10	0	0	0	-1	-1	-2	-2	-3	-3
20	0	0	1	2	3	5	6	9	10	0	0	1	2	3	5	6	7	9	0	0	0	0	-1	-1	-2	-3	-3
10	0	0	1	2	3	4	5	7	10	0	0	1	2	3	4	5	6	8	0	0	0	0	-1	-1	-2	-2	-2
0	0	0	1	2	3	4	5	7	9	0	0	1	2	3	4	5	6	7	0	0	0	0	-1	-1	-2	-2	-2
-60	2	2	3	4	4	5	6	8	10	0	0	1	2	3	4	5	6	7	0	0	0	0	-1	-1	-2	-2	-2

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
85	-3	-2	0	2	2	-2	-1	-1	0	1	2
80	-3	-2	0	2	2	-2	-1	-1	0	1	2
70	-2	-1	0	1	1	-2	-1	-1	0	1	2
60	-2	-1	0	1	1	-2	-1	-1	0	1	2
50	-1	-1	0	1	1	-2	-1	-1	0	1	2
40	-1	-1	0	1	1	-2	-1	-1	0	1	2

***V1 not to exceed VR.**

TO1 Takeoff Speeds - Dry Runway

10% Thrust Reduction

Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	94	92	90	89	87	85	83	79	74
55	94	92	90	89	87	85	83	79	74
50	97	94	91	89	87	85	83	79	74
45	100	97	93	90	87	85	83	79	74
40	103	100	96	92	89	85	83	79	74
35	106	103	99	95	91	87	83	79	74
30	107	106	102	97	93	89	85	80	74
25	107	106	104	100	95	91	87	82	75
20	107	107	104	101	97	93	89	84	77
15	107	107	104	101	98	95	90	86	79
10	107	107	104	101	98	95	92	87	81
5	107	107	104	101	98	95	92	88	83
0	107	107	104	101	98	95	92	88	84
-60	108	108	105	102	99	96	93	89	84

TO1 Takeoff Speeds - Wet Runway

10% Thrust Reduction

Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
85	155	164	169												
80	149	159	165	142	152	158	139	149	154						
75	143	154	160	136	147	153	133	144	150	131	141	147	129	138	144
70	136	148	156	130	141	149	127	138	146	125	135	143	122	132	140
65	130	142	151	124	135	144	121	132	141	119	130	138	116	127	136
60	122	135	146	117	129	139	114	126	136	112	123	133	110	121	131
55	115	128	140	110	122	134	107	119	131	105	117	128	103	114	126
50	107	120	134	103	115	128	100	112	126	98	110	123	96	107	121
45	100	112	128	95	107	122	93	105	120	91	103	117	89	100	115
40	91	104	121	87	100	116	84	97	114	82	95	111	80	93	109

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	9	10	10	10	10	11	13	15	17	5	6	6	6	7	7	8	8	10	-2	-2	-2	-3	-3	-3	-3	-4	-4
50	6	7	8	10	10	11	13	15	17	3	4	5	6	7	7	8	8	10	-1	-1	-2	-3	-3	-3	-3	-4	-4
40	2	4	5	7	9	11	13	15	17	1	2	3	5	6	7	8	8	10	0	-1	-1	-2	-2	-3	-3	-4	-4
30	0	0	2	4	6	9	11	14	17	0	0	1	3	4	6	7	8	10	0	0	0	-1	-1	-2	-2	-3	-3
20	0	0	1	2	4	6	8	11	15	0	0	1	2	3	5	6	7	9	0	0	0	0	-1	-1	-2	-3	-3
10	0	0	1	2	4	5	7	9	12	0	0	1	2	3	4	5	6	8	0	0	0	0	-1	-1	-2	-2	-2
0	0	0	1	2	4	5	7	9	11	0	0	1	2	3	4	5	6	7	0	0	0	0	-1	-1	-2	-2	-2
-60	2	2	3	4	6	7	8	10	12	0	0	1	2	3	4	5	6	7	0	0	0	0	-1	-1	-2	-2	-2

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
85	-6	-3	0	3	6	-3	-2	-1	0	1	2
80	-5	-3	0	3	5	-4	-2	-1	0	1	3
70	-4	-2	0	2	4	-4	-3	-1	0	2	3
60	-3	-2	0	2	4	-4	-3	-1	0	2	3
50	-3	-1	0	1	3	-4	-3	-1	0	2	3
40	-2	-1	0	1	2	-4	-3	-1	0	2	3

***V1 not to exceed VR.**

TO1 Takeoff Speeds - Wet Runway

10% Thrust Reduction

Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	94	92	90	89	87	85	83	79	74
55	94	92	90	89	87	85	83	79	74
50	97	94	91	89	87	85	83	79	74
45	100	97	93	90	87	85	83	79	74
40	103	100	96	92	89	85	83	79	74
35	106	103	99	95	91	87	83	79	74
30	107	106	102	97	93	89	85	80	74
25	107	106	104	100	95	91	87	82	75
20	107	107	104	101	97	93	89	84	77
15	107	107	104	101	98	95	90	86	79
10	107	107	104	101	98	95	92	87	81
5	107	107	104	101	98	95	92	88	83
0	107	107	104	101	98	95	92	88	84
-60	108	108	105	102	99	96	93	89	84

TO1 Stabilizer Trim Setting
10% Thrust Reduction
Flaps 1 and 5

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8 1/2	8 1/4	7 3/4	7 1/2	7	6 3/4	6 1/4	6	5 1/2	5 1/4	4 3/4	4 1/2	4	3 3/4
80	8 1/2	8 1/2	8 1/2	8	7 3/4	7 1/4	7	6 3/4	6 1/4	6	5 1/2	5 1/4	4 3/4	4 1/2	4	3 3/4
70	8 1/2	8 1/2	8	7 3/4	7 1/4	7	6 3/4	6 1/4	6	5 1/2	5 1/4	4 3/4	4 1/2	4	3 3/4	3 1/4
60	8 1/4	7 3/4	7 1/2	7 1/4	6 3/4	6 1/2	6 1/4	5 3/4	5 1/2	5	4 3/4	4 1/4	4	3 1/2	3 1/4	3
50	7 1/4	7	6 3/4	6 1/2	6	5 3/4	5 1/2	5	4 3/4	4 1/4	4	3 1/2	3 1/4	3	3	3
40	6	5 3/4	5 1/2	5 1/4	5	4 3/4	4 1/4	4	3 3/4	3 1/2	3	3	3	3	3	3

Flaps 10, 15, and 25

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8 1/2	8	7 1/4	6 3/4	6 1/4	6	5 1/2	5	4 1/2	4	3 3/4	3 1/4	3	3
80	8 1/2	8 1/2	8 1/2	7 3/4	7 1/4	6 1/2	6 1/4	5 3/4	5 1/4	5	4 1/2	4	3 1/2	3 1/4	3	3
70	8 1/2	8 1/2	8	7 1/4	6 3/4	6 1/4	5 3/4	5 1/2	5	4 1/2	4	3 3/4	3 1/4	3	3	3
60	8 1/2	8	7 1/4	6 3/4	6 1/4	5 1/2	5 1/4	4 3/4	4 1/2	4	3 1/2	3	3	3	3	3
50	7	6 1/2	6 1/4	5 3/4	5 1/4	4 3/4	4 1/4	4	3 1/2	3 1/4	3	3	3	3	3	3
40	5 1/4	5	4 1/2	4 1/4	4	3 3/4	3 1/4	3	3	3	3	3	3	3	3	3

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

10% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5.9	-7.5	-9.0	-10.3	-8.2	-9.8	-11.2	-12.6	-12.5	-14.0	-15.6	-16.9
80	-5.4	-6.9	-8.4	-9.8	-7.1	-8.6	-10.2	-11.5	-10.3	-11.8	-13.3	-14.7
70	-4.4	-5.9	-7.5	-8.8	-5.7	-7.2	-8.7	-10.1	-7.9	-9.5	-11.0	-12.3
60	-3.2	-4.7	-6.2	-7.6	-4.0	-5.5	-7.0	-8.4	-5.4	-6.9	-8.4	-9.8
50	-1.6	-3.1	-4.6	-6.0	-2.0	-3.5	-5.0	-6.4	-2.7	-4.2	-5.7	-7.1
40	0.0	-1.4	-2.9	-4.3	0.0	-1.4	-2.9	-4.3	0.0	-1.4	-2.9	-4.3

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	40.1	17.5			42.7	20.4			47.2	26.1		
1400	65.3	42.0	19.1		67.3	44.5	22.0		70.4	49.0	27.7	
1600	91.4	67.2	43.8	23.2	92.5	69.1	46.3	26.0	93.8	72.1	50.6	31.4
1800		93.2	68.9	47.8		94.2	70.9	50.3		95.4	73.6	54.3
2000			95.1	73.1			96.1	75.0			97.1	77.4
2200				99.3				100.1				100.9

1. **Enter Table 1 with slush/standing water depth and TO1 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-12	-7	-2	0	-9	-4	0	0	-1	0	0	0
80	-14	-9	-4	0	-11	-6	-1	0	-3	0	0	0
70	-15	-10	-5	-1	-13	-8	-3	0	-6	-1	0	0
60	-17	-12	-7	-2	-15	-10	-5	0	-10	-5	0	0
50	-19	-14	-9	-5	-18	-13	-8	-3	-14	-9	-4	0
40	-23	-18	-13	-8	-22	-17	-12	-7	-20	-15	-10	-5

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff
10% Thrust Reduction
No Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8.1	-9.7	-11.2	-12.6	-10.6	-12.2	-13.7	-15.1	-15.3	-16.8	-18.4	-19.7
80	-7.5	-9.0	-10.6	-12.0	-9.4	-10.9	-12.5	-13.8	-12.7	-14.3	-15.8	-17.2
70	-6.4	-8.0	-9.5	-10.9	-7.8	-9.3	-10.9	-12.3	-10.1	-11.6	-13.2	-14.6
60	-5.0	-6.5	-8.1	-9.5	-5.9	-7.4	-8.9	-10.3	-7.3	-8.8	-10.3	-11.7
50	-3.1	-4.7	-6.2	-7.6	-3.6	-5.1	-6.7	-8.1	-4.3	-5.8	-7.3	-8.8
40	-0.8	-2.4	-3.9	-5.3	-1.0	-2.5	-4.0	-5.4	-1.1	-2.7	-4.2	-5.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1400									38.5			
1500	23.7				38.4				55.4			
1600	49.9				60.0	19.7			71.4	41.7		
1700	73.0	28.4			79.2	42.4			86.5	58.5	27.9	
1800	92.7	54.8			96.9	63.9	23.7		101.2	74.4	44.8	
1900		77.3	33.5			82.7	47.0			89.4	61.6	33.9
2000		96.0	59.6	16.0		99.4	67.8	32.6		103.8	77.3	51.2
2100			80.7	43.5			85.8	54.7			92.0	67.4
2200			99.4	67.5			103.4	74.4				82.7
2300				87.8				92.0				97.7
2400				106.1								

1. **Enter Table 1 with slush/standing water depth and TO1 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -35 m/+35 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-16	-11	-6	-2	-12	-7	-2	0	-1	0	0	0
80	-18	-13	-8	-4	-14	-9	-4	0	-4	0	0	0
70	-21	-16	-11	-7	-18	-13	-8	-3	-8	-3	0	0
60	-24	-19	-14	-10	-21	-16	-11	-7	-14	-9	-4	0
50	-28	-23	-18	-13	-26	-21	-16	-11	-21	-16	-11	-6
40	-32	-27	-22	-17	-31	-26	-21	-16	-28	-23	-18	-13

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff

10% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4.2	-5.6	-6.9	-8.2	-5.9	-7.3	-8.7	-9.9	-9.3	-10.7	-12.0	-13.2
80	-4.4	-5.8	-7.1	-8.3	-5.8	-7.1	-8.5	-9.7	-8.3	-9.6	-11.0	-12.2
70	-4.1	-5.4	-6.8	-8.0	-5.1	-6.4	-7.8	-9.0	-6.8	-8.2	-9.6	-10.8
60	-3.2	-4.6	-5.9	-7.2	-3.9	-5.3	-6.6	-7.8	-5.1	-6.4	-7.8	-9.0
50	-1.9	-3.2	-4.6	-5.8	-2.2	-3.6	-4.9	-6.2	-2.9	-4.3	-5.6	-6.8
40	-0.1	-1.5	-2.8	-4.0	-0.1	-1.5	-2.8	-4.0	-0.4	-1.8	-3.1	-4.4

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	43.3	21.8			46.8	26.4			50.6	32.1		
1400	68.4	46.4	24.7		70.5	49.8	29.3		72.4	53.4	34.8	
1600	93.8	71.5	49.6	30.0	94.6	73.4	52.6	34.2	94.7	75.2	56.1	39.3
1800		97.0	74.7	54.8		97.6	76.4	57.6		97.5	77.9	60.6
2000			100.2	80.0			100.6	81.5			100.3	82.5
2200				105.6				105.7				105.1

1. **Enter Table 1 with dry snow depth and TO1 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-9	-4	0	0	-6	-1	0	0	0	0	0	0
80	-11	-6	-1	0	-8	-3	0	0	-3	0	0	0
70	-14	-9	-4	0	-11	-6	-1	0	-6	-1	0	0
60	-16	-11	-6	-2	-14	-9	-4	0	-9	-4	0	0
50	-19	-14	-9	-5	-17	-12	-7	-2	-13	-8	-3	0
40	-22	-17	-12	-7	-20	-15	-10	-5	-16	-11	-6	-2

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6.0	-7.2	-8.3	-9.4	-7.8	-9.0	-10.2	-11.2	-11.2	-12.3	-13.5	-14.6
80	-6.4	-7.5	-8.7	-9.8	-7.7	-8.9	-10.1	-11.1	-10.2	-11.4	-12.6	-13.7
70	-6.1	-7.3	-8.4	-9.5	-7.0	-8.2	-9.4	-10.4	-8.8	-10.0	-11.2	-12.2
60	-5.2	-6.4	-7.5	-8.6	-5.8	-6.9	-8.1	-9.2	-6.9	-8.1	-9.3	-10.4
50	-3.6	-4.8	-6.0	-7.0	-3.9	-5.1	-6.3	-7.4	-4.6	-5.8	-7.0	-8.0
40	-1.5	-2.7	-3.9	-4.9	-1.6	-2.8	-3.9	-5.0	-1.8	-3.0	-4.2	-5.3

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1300									39.2			
1400	21.6				39.6				52.6	29.9		
1500	45.9				57.1	26.9			65.8	43.4		
1600	66.8	30.6			73.4	45.0			79.0	56.7	34.1	
1700	84.9	52.4			88.7	62.2	32.5		92.0	69.9	47.4	
1800	101.4	72.8	36.5		103.4	78.3	50.5			83.0	60.7	40.5
1900		90.2	59.6	23.8		93.4	67.5	41.2		96.0	73.9	53.9
2000			78.5	48.2			83.1	58.8			87.0	67.1
2100			94.9	68.7			97.7	75.0			100.0	80.2
2200				86.4				90.1				93.2
2300				103.0								

1. **Enter Table 1 with dry snow depth and TO1 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-11	-6	-1	0	-7	-2	0	0	0	0	0	0
80	-15	-10	-5	0	-11	-6	-1	0	-4	0	0	0
70	-18	-13	-8	-4	-15	-10	-5	0	-8	-3	0	0
60	-22	-17	-12	-8	-19	-14	-9	-5	-13	-8	-3	0
50	-27	-22	-17	-12	-24	-19	-14	-9	-18	-13	-8	-3
40	-32	-27	-22	-17	-28	-23	-18	-14	-23	-18	-13	-9

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff

10% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4.9	-6.3	-7.6	-8.8	-6.7	-8.0	-9.3	-10.5	-11.9	-13.2	-14.5	-15.7
80	-4.9	-6.3	-7.6	-8.8	-6.3	-7.6	-8.9	-10.1	-10.2	-11.5	-12.8	-14.0
70	-4.4	-5.7	-7.0	-8.2	-5.4	-6.7	-8.0	-9.2	-8.1	-9.4	-10.8	-11.9
60	-3.3	-4.6	-5.9	-7.1	-3.9	-5.2	-6.5	-7.7	-5.7	-7.0	-8.3	-9.5
50	-1.6	-2.9	-4.2	-5.4	-1.9	-3.2	-4.5	-5.7	-2.8	-4.1	-5.4	-6.6
40	0.0	-0.9	-2.2	-3.4	0.0	-0.9	-2.2	-3.4	0.0	-0.9	-2.2	-3.4

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	41.5	19.7			43.8	22.6			48.1	28.7		
1400	67.2	44.9	22.9		68.7	47.1	25.7		70.9	51.1	31.6	
1600	93.5	70.6	48.3	28.5	94.0	72.0	50.4	31.2	94.0	73.9	54.1	36.5
1800		97.0	74.0	53.8		97.3	75.4	55.8		97.0	76.9	59.0
2000			100.5	79.8			100.7	80.8			100.1	81.9
2200				106.3				106.2				105.1

1. **Enter Table 1 with wet snow depth and TO1 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-9	-4	0	0	-6	-1	0	0	0	0	0	0
80	-12	-7	-2	0	-9	-4	0	0	-1	0	0	0
70	-14	-9	-4	0	-11	-6	-1	0	-4	0	0	0
60	-17	-12	-7	-2	-14	-9	-4	0	-8	-3	0	0
50	-20	-15	-10	-5	-18	-13	-8	-4	-14	-9	-4	0
40	-24	-19	-14	-10	-23	-18	-13	-9	-21	-16	-11	-6

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-6.6	-7.9	-9.2	-10.4	-8.6	-9.8	-11.2	-12.3	-14.1	-15.4	-16.6	-17.8
80	-6.8	-8.1	-9.4	-10.6	-8.2	-9.5	-10.8	-12.0	-12.3	-13.6	-14.9	-16.1
70	-6.4	-7.7	-9.0	-10.1	-7.3	-8.6	-9.9	-11.0	-10.2	-11.5	-12.7	-13.9
60	-5.3	-6.5	-7.8	-9.0	-5.8	-7.1	-8.3	-9.5	-7.6	-8.9	-10.2	-11.3
50	-3.4	-4.8	-6.0	-7.2	-3.7	-4.9	-6.3	-7.4	-4.6	-5.9	-7.2	-8.3
40	-1.0	-2.3	-3.6	-4.8	-1.0	-2.3	-3.5	-4.7	-1.1	-2.4	-3.7	-4.9

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1300									27.4			
1400					24.1				44.6			
1500	37.3				48.1				60.7	33.4		
1600	62.2	19.3			68.4	32.4			75.8	50.1		
1700	82.6	45.8			85.9	55.1			89.9	65.9	39.0	
1800	100.5	69.9	27.6		101.9	74.8	40.2		103.5	80.7	55.6	30.6
1900		89.0	55.5	13.3		91.6	62.6	28.5		94.6	71.1	47.6
2000		105.4	76.9	42.7			80.7	52.2			85.5	63.6
2100			94.4	66.4			96.6	71.8			99.1	78.4
2200				85.9				88.8				92.4
2300				103.6				104.7				

1. **Enter Table 1 with wet snow depth and TO1 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-11	-6	-1	0	-7	-2	0	0	0	0	0	0
80	-15	-10	-5	-1	-11	-6	-1	0	-1	0	0	0
70	-19	-14	-9	-5	-15	-10	-5	-1	-5	0	0	0
60	-23	-18	-13	-9	-20	-15	-10	-6	-12	-7	-2	0
50	-28	-23	-18	-14	-26	-21	-16	-12	-20	-15	-10	-6
40	-35	-30	-25	-20	-33	-28	-23	-19	-30	-25	-20	-15

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-1.0	-1.8	-2.5	-3.3	-2.7	-3.5	-4.3	-5.0	-9.9	-10.8	-11.5	-12.2
80	-1.2	-2.0	-2.8	-3.4	-3.2	-4.0	-4.8	-5.5	-9.5	-10.3	-11.1	-11.8
70	-1.0	-1.8	-2.6	-3.3	-3.1	-3.9	-4.7	-5.4	-8.5	-9.3	-10.1	-10.8
60	-0.4	-1.2	-2.0	-2.7	-2.5	-3.4	-4.1	-4.9	-7.0	-7.8	-8.6	-9.3
50	0.0	-0.8	-1.6	-2.4	-1.5	-2.2	-3.0	-3.8	-4.9	-5.7	-6.5	-7.2
40	0.0	-0.8	-1.6	-2.3	0.0	-0.8	-1.6	-2.3	-2.3	-3.0	-3.9	-4.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	74.1	49.6	21.7		40.7	18.1						
1400	105.0	82.9	58.7	34.8	67.4	44.3	21.5					
1600		113.8	91.6	70.8	95.1	71.0	47.8	27.2				
1800				102.8		98.7	74.6	53.6	36.2			
2000							102.5	80.6	47.8			
2200								108.6	60.2	38.9		
2400									73.7	50.6		
2600									89.0	63.2	41.6	
2800									104.8	77.2	53.5	34.8
3000										92.7	66.3	46.4
3200											80.6	58.6
3400											96.4	72.0
3600												86.9
3800												103.4

1. **Enter Table 1 with reported braking action and TO1 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -25 m/+25 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -30 m/+30 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -55 m/+55 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8	-5	-3	-1	-12	-9	-7	-5	-31	-29	-26	-24
80	-9	-7	-4	-2	-14	-11	-9	-7	-35	-32	-30	-28
70	-10	-8	-5	-3	-16	-14	-11	-9	-38	-35	-33	-31
60	-11	-9	-6	-4	-18	-16	-13	-11	-40	-38	-35	-33
50	-12	-9	-7	-5	-21	-18	-16	-13	-43	-40	-38	-35
40	-12	-10	-7	-5	-23	-21	-18	-16	-44	-42	-39	-37

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-2.4	-3.3	-4.0	-4.8	-4.5	-5.3	-6.1	-6.8	-13.4	-14.2	-15.0	-15.7
80	-2.6	-3.4	-4.2	-4.9	-5.2	-5.9	-6.8	-7.4	-13.1	-13.8	-14.7	-15.4
70	-2.4	-3.1	-3.9	-4.6	-5.1	-5.9	-6.7	-7.4	-11.8	-12.6	-13.4	-14.1
60	-1.6	-2.4	-3.2	-3.9	-4.5	-5.3	-6.1	-6.8	-9.6	-10.4	-11.2	-11.9
50	-0.5	-1.2	-2.0	-2.8	-3.2	-3.9	-4.8	-5.4	-6.5	-7.3	-8.1	-8.8
40	0.0	-0.8	-1.6	-2.3	-1.2	-2.0	-2.8	-3.5	-2.5	-3.4	-4.1	-4.9

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	56.4											
1300	76.7	32.9										
1400	95.4	67.5	14.4									
1500		88.0	55.1	11.1	33.3							
1600		106.3	80.2	45.6	61.9	9.6						
1700			98.1	74.5	83.6	43.1						
1800				93.5	101.7	69.5	20.7					
1900						89.6	52.7					
2000						107.3	76.6	37.5				
2100							95.8	65.2				
2200								86.3				
2300								104.2				
3600									78.2			
3700									93.5			
3900										21.0		
4000										81.8		
4100										96.6		
4300											54.5	
4400											85.5	
4500											100.2	

1. **Enter Table 1 with reported braking action and TO1 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -25 m/+25 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -30 m/+30 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -80 m/+80 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff
10% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-10	-5	0	0	-15	-10	-5	-1	-48	-43	-38	-34
80	-12	-7	-2	0	-18	-13	-8	-4	-54	-49	-44	-40
70	-13	-8	-3	0	-22	-17	-12	-7	-60	-55	-50	-45
60	-14	-9	-4	0	-25	-20	-15	-11	-65	-60	-55	-50
50	-16	-11	-6	-1	-29	-24	-19	-15	-69	-64	-59	-55
40	-17	-12	-7	-2	-33	-28	-23	-19	-73	-68	-63	-58

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

TO1 Takeoff %N1
10% Thrust Reduction
Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	81.6	82.0	82.5	82.6	82.6	82.6	82.6	82.6	82.6	82.6	82.4	82.0	81.7	80.7	79.8	78.7	77.5	76.9
55	83.0	83.4	83.8	83.9	83.9	83.9	83.9	83.9	83.9	83.9	83.7	83.3	83.0	82.0	81.1	80.0	78.9	78.3
50	84.5	84.9	85.3	85.2	85.2	85.2	85.2	85.2	85.2	85.2	85.0	84.6	84.2	83.3	82.4	81.3	80.2	79.6
45	85.9	86.3	86.7	86.6	86.6	86.5	86.4	86.4	86.4	86.4	86.2	85.8	85.5	84.6	83.7	82.5	81.4	80.9
40	87.2	87.6	88.0	88.0	87.9	87.9	87.8	87.7	87.6	87.5	87.3	87.0	86.6	85.7	84.9	83.8	82.7	82.1
35	88.4	88.9	89.3	89.3	89.3	89.2	89.0	88.9	88.6	88.4	88.2	88.0	87.7	86.9	86.0	84.9	83.9	83.4
30	88.0	89.3	90.6	90.4	90.4	90.2	90.0	89.8	89.5	89.2	88.9	88.7	88.6	87.8	87.0	86.1	85.1	84.6
25	87.2	88.5	89.8	90.3	90.9	91.1	90.9	90.7	90.4	90.1	89.8	89.6	89.4	88.6	87.8	87.0	86.2	85.7
20	86.5	87.7	88.9	89.4	90.0	90.5	91.0	91.3	91.1	90.9	90.5	90.3	90.2	89.5	88.7	87.9	87.1	86.7
15	85.7	86.9	88.1	88.6	89.2	89.7	90.2	90.5	90.6	90.8	90.8	90.7	90.5	89.9	89.3	88.7	87.8	87.4
10	84.9	86.1	87.3	87.8	88.4	88.9	89.4	89.7	89.8	89.9	90.2	90.6	90.8	90.1	89.5	88.9	88.4	88.1
5	84.1	85.3	86.6	87.0	87.6	88.2	88.6	88.9	89.0	89.1	89.4	89.8	90.0	89.9	89.7	89.4	88.8	88.5
0	83.3	84.6	85.8	86.3	86.8	87.4	87.8	88.1	88.2	88.3	88.5	89.0	89.2	89.0	88.9	88.8	88.8	88.8
-5	82.5	83.7	85.0	85.5	86.0	86.5	87.0	87.3	87.4	87.5	87.7	88.2	88.4	88.2	88.1	88.0	88.0	87.9
-10	81.7	82.9	84.1	84.7	85.2	85.7	86.2	86.4	86.5	86.6	86.9	87.3	87.6	87.4	87.3	87.2	87.1	87.1
-15	80.9	82.1	83.4	83.9	84.4	84.9	85.3	85.6	85.7	85.8	86.1	86.5	86.7	86.6	86.5	86.4	86.3	86.3
-20	80.2	81.4	82.5	83.1	83.6	84.1	84.5	84.8	84.9	85.0	85.3	85.7	85.9	85.8	85.6	85.6	85.5	85.5
-25	79.4	80.6	81.7	82.2	82.8	83.2	83.6	83.9	84.1	84.2	84.5	84.9	85.1	85.0	84.8	84.7	84.7	84.7
-30	78.6	79.7	80.9	81.4	82.0	82.4	82.8	83.1	83.2	83.3	83.6	84.1	84.3	84.1	84.0	83.9	83.9	83.9
-35	77.8	78.9	80.1	80.6	81.1	81.6	82.0	82.3	82.4	82.5	82.8	83.2	83.4	83.3	83.1	83.1	83.1	83.0
-40	77.0	78.1	79.3	79.8	80.3	80.8	81.1	81.4	81.5	81.7	81.9	82.4	82.5	82.4	82.3	82.2	82.2	82.2
-45	76.2	77.3	78.4	78.9	79.5	79.9	80.3	80.6	80.7	80.8	81.0	81.5	81.6	81.5	81.4	81.4	81.4	81.4
-50	75.3	76.4	77.6	78.1	78.6	79.0	79.4	79.7	79.8	79.9	80.2	80.6	80.7	80.6	80.5	80.5	80.5	80.5

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.7	0.8	0.8	0.9	1.0	0.9	1.0	1.0	1.1	1.2	1.4	1.4	1.6	1.8	2.0	2.0	2.0	2.1
ENGINE ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.9	-0.9	-0.9	-0.8	-0.9	-0.9

TO1 Assumed Temperature Reduced Thrust

Maximum Assumed Temperature (Table 1 of 3)

Based on 25% Takeoff Thrust Reduction

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	76	77	78	78	78	78	78	78	78	78	78	77	76	73	71	68	65	63
55	76	77	78	78	78	78	78	78	78	78	78	77	76	73	71	68	65	63
50	74	74	74	75	75	75	75	75	75	75	75	75	75	73	71	68	65	63
45	69	69	69	69	70	70	71	71	71	71	71	71	70	70	70	68	65	63
40	64	64	64	64	65	65	65	66	66	66	66	66	66	66	66	65	64	63
35	59	59	59	59	59	60	61	61	61	62	62	61	61	61	61	61	60	60
30	58	56	54	54	55	56	56	57	57	58	58	57	57	57	56	56	56	56
25	58	56	54	53	52	51	52	53	53	54	53	53	53	53	52	52	51	51
20	58	57	54	53	52	51	49	49	49	49	49	49	49	48	48	47	47	47
15	59	57	54	53	52	51	49	49	48	48	47	46	46	44	43	43	42	42
10	59	57	54	53	52	51	50	49	48	48	46	44	42	41	40	39	38	37
5	59	57	54	53	52	51	50	49	48	48	46	44	42	40	37	36	34	34
0	59	57	55	53	52	51	50	49	48	48	46	44	42	40	37	35	32	31
-5 & BELOW	59	57	55	53	52	51	50	49	48	48	46	44	42	39	37	35	33	31

Takeoff %N1 (Table 2 of 3)

Based on engine bleed for packs on and engine anti-ice off

ASSUMED TEMP (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
75	77.5	77.9	78.4	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.3	77.9	77.6	77.1	77.1	77.1	77.1	77.1
70	78.9	79.3	79.8	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.7	79.3	78.9	78.0	77.1	76.6	76.6	76.6
65	80.2	80.7	81.2	81.2	81.3	81.3	81.3	81.3	81.3	81.3	81.1	80.7	80.3	79.4	78.4	77.3	76.1	76.0
60	81.6	82.0	82.5	82.6	82.6	82.6	82.6	82.6	82.6	82.6	82.4	82.0	81.7	80.7	79.8	78.7	77.5	76.9
55	83.0	83.4	83.8	83.9	83.9	83.9	83.9	83.9	83.9	83.9	83.7	83.3	83.0	82.0	81.1	80.0	78.9	78.3
50	84.5	84.9	85.3	85.2	85.2	85.2	85.2	85.2	85.2	85.2	85.0	84.6	84.2	83.3	82.4	81.3	80.2	79.6
45	85.9	86.3	86.7	86.6	86.6	86.5	86.4	86.4	86.4	86.4	86.2	85.8	85.5	84.6	83.7	82.5	81.4	80.9
40	87.2	87.6	88.0	88.0	87.9	87.9	87.8	87.7	87.6	87.5	87.3	87.0	86.6	85.7	84.9	83.8	82.7	82.1
35	88.4	88.9	89.3	89.3	89.3	89.2	89.0	88.9	88.6	88.4	88.2	88.0	87.7	86.9	86.0	84.9	83.9	83.4
30	88.0	89.3	90.6	90.4	90.4	90.2	90.0	89.8	89.5	89.2	88.9	88.7	88.6	87.8	87.0	86.1	85.1	84.6
25	87.2	88.5	89.8	90.3	90.9	91.1	90.9	90.7	90.4	90.1	89.8	89.6	89.4	88.6	87.8	87.0	86.2	85.7
20	86.5	87.7	88.9	89.4	90.0	90.5	91.0	91.3	91.1	90.9	90.5	90.3	90.2	89.5	88.7	87.9	87.1	86.7
15	85.7	86.9	88.1	88.6	89.2	89.7	90.2	90.5	90.6	90.8	90.8	90.7	90.5	89.9	89.3	88.7	87.8	87.4
10	84.9	86.1	87.3	87.8	88.4	88.9	89.4	89.7	89.8	89.9	90.2	90.6	90.8	90.1	89.5	88.9	88.4	88.1
5	84.1	85.3	86.6	87.0	87.6	88.2	88.6	88.9	89.0	89.1	89.4	89.8	90.0	89.9	89.7	89.4	88.8	88.5
0	83.3	84.6	85.8	86.3	86.8	87.4	87.8	88.1	88.2	88.3	88.5	89.0	89.2	89.0	88.9	88.8	88.8	88.8
-5	82.5	83.7	85.0	85.5	86.0	86.5	87.0	87.3	87.4	87.5	87.7	88.2	88.4	88.2	88.1	88.0	88.0	87.9
-20	80.2	81.4	82.5	83.1	83.6	84.1	84.5	84.8	84.9	85.0	85.3	85.7	85.9	85.8	85.6	85.6	85.5	85.5
-40	77.0	78.1	79.3	79.8	80.3	80.8	81.1	81.4	81.5	81.7	81.9	82.4	82.5	82.4	82.3	82.2	82.2	82.2
MINIMUM ASSUMED TEMP (°C)	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	1

TO1 Assumed Temperature Reduced Thrust

%N1 Adjustment for Temperature Difference (Table 3 of 3)

ASSUMED TEMP MINUS OAT (°C)	OUTSIDE AIR TEMPERATURE (°C)													
	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
115	8.4													
110	8.4													
105	8.4													
100	8.4													
95	7.0	8.7												
90	5.2	8.7												
85	3.5	8.7												
80	1.8	8.7												
75	0.1	7.3	9.1											
70	0.0	5.4	9.0	8.9										
65	0.0	3.6	8.4	8.4	8.3									
60	0.0	1.8	7.9	7.8	7.8	7.7								
55	0.0	0.1	7.3	7.3	7.2	7.2	7.1							
50	0.0	0.0	5.6	6.7	6.6	6.6	6.5	6.3						
45	0.0	0.0	3.7	5.7	6.0	6.0	5.9	5.8	5.6					
40	0.0	0.0	1.9	3.8	5.4	5.4	5.3	5.2	5.0	4.9				
35		0.0	0.1	2.0	3.9	4.8	4.7	4.6	4.5	4.3	4.2			
30		0.0	0.0	0.1	2.0	3.9	4.1	4.0	3.9	3.7	3.6	3.5		
25		0.0	0.0	0.0	0.2	2.1	3.5	3.4	3.3	3.2	3.1	3.0	2.9	
20		0.0	0.0	0.0	0.0	0.2	2.1	2.7	2.6	2.6	2.5	2.4	2.3	2.3
15			0.0	0.0	0.0	0.0	0.3	2.1	2.0	1.9	1.9	1.8	1.8	1.7
10			0.0	0.0	0.0	0.0	0.0	0.3	1.3	1.3	1.3	1.2	1.2	1.2
5			0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.6	0.6	0.6	0.6
0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1. **Determine Maximum Assumed Temperature allowed from Table 1.**
2. **Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).**
3. **Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.**
4. **Subtract %N1 adjustment from Maximum %N1 in Table 2.**

TO2 Takeoff Speeds - Dry Runway

20% Thrust Reduction

Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
75	155	155	160												
70	149	149	156	143	143	149	140	140	145	137	137	142	134	134	139
65	143	143	151	137	137	144	134	134	141	131	131	138	128	128	135
60	137	137	146	131	131	139	128	128	136	125	125	133	122	122	130
55	130	130	140	124	124	134	121	121	131	118	118	128	116	116	125
50	122	122	134	117	117	128	114	114	125	111	111	123	109	109	120
45	114	114	128	109	109	122	107	107	119	104	104	117	102	102	115
40	106	106	121	101	101	116	99	99	113	96	96	111	95	95	109

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	5	5	5	5	5	6	7	8	9	4	5	6	6	7	7	8	8	10	-2	-2	-3	-3	-3	-4	-4	-4	-4
50	3	3	5	5	5	6	7	8	9	3	4	5	6	7	7	8	8	10	-1	-2	-2	-2	-3	-4	-4	-4	-4
40	1	2	4	5	5	6	7	8	9	1	2	3	4	5	6	8	8	10	-1	-1	-2	-2	-2	-3	-3	-4	-4
30	0	0	1	2	4	6	6	8	9	0	0	1	3	4	5	7	8	10	0	0	-1	-1	-2	-2	-3	-3	-3
20	0	0	1	1	3	4	5	7	9	0	0	1	2	3	4	6	7	9	0	0	-1	-1	-1	-2	-2	-3	-3
10	0	0	1	1	3	4	4	6	8	0	0	1	2	3	4	5	6	8	0	0	-1	-1	-1	-2	-2	-2	-3
0	0	0	1	1	3	4	4	6	7	0	0	1	2	3	4	5	6	7	0	0	-1	-1	-1	-2	-2	-2	-3
-60	0	0	1	1	3	4	4	6	7	0	0	1	2	3	4	5	6	7	0	0	-1	-1	-1	-2	-2	-2	-3

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
75	-3	-2	0	0	0	-1	-1	0	0	0	0
70	-3	-1	0	0	0	-1	-1	0	0	0	0
60	-2	-1	0	0	0	-2	-1	-1	0	0	0
50	-1	-1	0	0	0	-2	-1	-1	0	0	0
40	-1	-1	0	0	0	-2	-1	-1	0	0	0

***V1 not to exceed VR.**

TO2 Takeoff Speeds - Dry Runway
20% Thrust Reduction
Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	89	87	86	84	83	81	79	74	70
55	89	87	86	84	83	81	79	74	70
50	92	89	86	84	83	81	79	74	70
45	95	92	88	85	83	81	79	74	70
40	97	95	91	87	84	81	79	74	70
35	100	97	94	90	86	82	79	74	70
30	101	100	96	92	88	84	80	75	70
25	101	100	98	94	90	86	82	77	71
20	101	100	98	95	92	88	84	79	73
15	101	100	98	95	92	89	85	81	75
10	101	101	98	95	92	90	87	82	77
5	101	101	98	95	92	90	87	83	78
0	101	101	98	96	92	90	87	83	79
-60	102	101	99	96	93	90	88	84	80

TO2 Takeoff Speeds - Wet Runway

20% Thrust Reduction

Table 1 of 4: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 1			FLAPS 5			FLAPS 10			FLAPS 15			FLAPS 25		
	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2	V1	VR	V2
75	147	155	160												
70	141	149	156	135	143	149	132	140	145	130	137	142	127	134	139
65	134	143	151	128	137	144	125	134	141	123	131	138	121	128	135
60	127	137	146	121	131	139	118	128	136	116	125	133	114	122	130
55	119	130	140	114	124	134	111	121	131	109	118	128	107	116	125
50	112	122	134	107	117	128	104	114	125	102	111	123	100	109	120
45	104	114	128	99	109	122	96	107	119	94	104	117	92	102	115
40	95	106	121	91	101	116	88	99	113	86	96	111	84	95	109

Check V1(MCG).

Table 2 of 4: V1, VR, V2 Adjustments*

TEMP (°C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																										
	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5	-2	0	2	4	6	8	10	12	14.5
60	8	9	9	9	10	10	11	13	14	4	5	6	6	7	7	8	8	10	-2	-2	-3	-3	-3	-4	-4	-4	-4
50	5	6	8	9	10	10	11	13	14	3	4	5	6	7	7	8	8	10	-1	-2	-2	-2	-3	-4	-4	-4	-4
40	1	3	5	6	8	10	11	13	14	1	2	3	4	5	6	8	8	10	-1	-1	-2	-2	-2	-3	-3	-4	-4
30	0	0	1	3	6	8	10	13	14	0	0	1	3	4	5	7	8	10	0	0	-1	-1	-2	-2	-3	-3	-3
20	0	0	1	2	3	5	7	11	14	0	0	1	2	3	4	6	7	9	0	0	-1	-1	-1	-2	-2	-3	-3
10	0	0	1	2	3	5	6	9	11	0	0	1	2	3	4	5	6	8	0	0	-1	-1	-1	-2	-2	-2	-3
0	0	0	1	2	3	5	6	8	10	0	0	1	2	3	4	5	6	7	0	0	-1	-1	-1	-2	-2	-2	-3
-60	2	2	3	4	5	6	7	9	11	0	0	1	2	3	4	5	6	7	0	0	-1	-1	-1	-2	-2	-2	-3

***V1 not to exceed VR.**

Table 3 of 4: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	-2	-1	0	1	2	-15	-10	-5	0	20	40
75	-5	-3	0	3	5	-3	-2	-1	0	1	2
70	-4	-2	0	2	5	-3	-2	-1	0	1	3
60	-3	-2	0	2	4	-4	-2	-1	0	2	3
50	-3	-1	0	1	3	-4	-3	-1	0	2	3
40	-2	-1	0	1	2	-4	-3	-1	0	2	3

***V1 not to exceed VR.**

TO2 Takeoff Speeds - Wet Runway

20% Thrust Reduction

Table 4 of 4: V1(MCG)

TEMP (°C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
60	89	87	86	84	83	81	79	74	70
55	89	87	86	84	83	81	79	74	70
50	92	89	86	84	83	81	79	74	70
45	95	92	88	85	83	81	79	74	70
40	97	95	91	87	84	81	79	74	70
35	100	97	94	90	86	82	79	74	70
30	101	100	96	92	88	84	80	75	70
25	101	100	98	94	90	86	82	77	71
20	101	100	98	95	92	88	84	79	73
15	101	100	98	95	92	89	85	81	75
10	101	101	98	95	92	90	87	82	77
5	101	101	98	95	92	90	87	83	78
0	101	101	98	96	92	90	87	83	79
-60	102	101	99	96	93	90	88	84	80

TO2 Stabilizer Trim Setting
20% Thrust Reduction
Flaps 1 and 5

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8 1/2	8 1/2	8 1/4	8	7 1/2	7 1/4	6 3/4	6 1/2	6	5 3/4	5 1/4	5	4 1/2	4 1/4
80	8 1/2	8 1/2	8 1/2	8 1/2	8 1/4	7 3/4	7 1/2	7	6 3/4	6 1/4	6	5 3/4	5 1/4	5	4 1/2	4 1/4
70	8 1/2	8 1/2	8 1/2	8 1/4	8	7 1/2	7 1/4	6 3/4	6 1/2	6	5 3/4	5 1/4	5	4 1/2	4 1/4	3 3/4
60	8 1/2	8 1/2	8 1/4	8	7 1/2	7 1/4	6 3/4	6 1/2	6 1/4	5 3/4	5 1/4	5	4 1/2	4 1/4	3 3/4	3 1/2
50	8 1/4	8	7 1/2	7 1/4	7	6 1/2	6 1/4	6	5 1/2	5 1/4	4 3/4	4 1/2	4	3 3/4	3 1/4	3
40	7 1/4	7	6 3/4	6 1/4	6	5 3/4	5 1/4	5	4 3/4	4 1/4	4	3 1/2	3 1/4	3	3	3

Flaps 10, 15, and 25

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)															
	C.G. (%MAC)															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
82	8 1/2	8 1/2	8 1/2	8 1/2	7 3/4	7	6 3/4	6 1/4	6	5 1/2	5	4 1/2	4 1/4	3 3/4	3 1/4	3
80	8 1/2	8 1/2	8 1/2	8 1/2	7 3/4	7	6 3/4	6 1/4	5 3/4	5 1/2	5	4 1/2	4 1/4	3 3/4	3 1/4	3
70	8 1/2	8 1/2	8 1/2	8	7 1/4	6 3/4	6 1/2	6	5 1/2	5	4 3/4	4 1/4	3 3/4	3 1/4	3	3
60	8 1/2	8 1/2	8 1/4	7 1/2	7	6 1/4	6	5 1/2	5 1/4	4 3/4	4 1/4	3 3/4	3 1/4	3	3	3
50	8	7 1/2	7 1/4	6 3/4	6 1/4	5 3/4	5 1/4	5	4 1/2	4	3 1/2	3	3	3	3	3
40	6 1/2	6	5 3/4	5 1/2	5	4 3/4	4 1/4	4	3 1/2	3	3	3	3	3	3	3

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

20% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5.7	-7.2	-8.8	-10.1	-8.1	-9.6	-11.2	-12.5	-12.7	-14.2	-15.8	-17.1
80	-5.2	-6.8	-8.3	-9.7	-7.1	-8.6	-10.2	-11.5	-10.6	-12.1	-13.6	-15.0
70	-4.5	-6.0	-7.5	-8.9	-5.9	-7.3	-8.9	-10.3	-8.3	-9.8	-11.3	-12.7
60	-3.4	-4.9	-6.4	-7.8	-4.3	-5.8	-7.3	-8.7	-5.9	-7.3	-8.9	-10.3
50	-1.9	-3.4	-4.9	-6.3	-2.4	-3.9	-5.4	-6.8	-3.2	-4.7	-6.2	-7.6
40	0.0	-1.5	-3.0	-4.4	-0.1	-1.6	-3.1	-4.5	-0.3	-1.8	-3.3	-4.7

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	50.9	27.0			53.3	29.8			57.4	35.1		
1400	77.8	53.0	28.9		79.4	55.3	31.7		81.6	59.1	36.8	
1600	105.4	79.7	54.9	33.1	106.0	81.4	57.1	35.8	106.3	83.4	60.8	40.7
1800		107.5	81.7	59.2		107.9	83.2	61.4		108.1	85.2	64.7
2000			109.2	86.2			109.7	87.5			109.7	89.1
2200				114.0				114.2				113.7

1. **Enter Table 1 with slush/standing water depth and TO2 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-11	-6	-1	0	-7	-2	0	0	0	0	0	0
80	-13	-8	-3	0	-9	-4	0	0	0	0	0	0
70	-14	-9	-4	0	-11	-6	-1	0	-4	0	0	0
60	-16	-11	-6	-2	-14	-9	-4	0	-8	-3	0	0
50	-19	-14	-9	-4	-17	-12	-7	-3	-13	-8	-3	0
40	-23	-18	-13	-8	-22	-17	-12	-7	-19	-14	-9	-5

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-7.7	-9.2	-10.8	-12.1	-10.3	-11.8	-13.4	-14.8	-15.4	-17.0	-18.5	-19.9
80	-7.2	-8.8	-10.3	-11.7	-9.3	-10.8	-12.3	-13.7	-13.0	-14.5	-16.1	-17.5
70	-6.4	-7.9	-9.5	-10.9	-7.8	-9.4	-10.9	-12.3	-10.4	-12.0	-13.5	-14.9
60	-5.1	-6.7	-8.2	-9.6	-6.1	-7.6	-9.2	-10.6	-7.7	-9.2	-10.8	-12.2
50	-3.4	-4.9	-6.5	-7.9	-3.9	-5.5	-7.0	-8.4	-4.8	-6.3	-7.8	-9.2
40	-1.2	-2.8	-4.3	-5.7	-1.4	-2.9	-4.5	-5.9	-1.7	-3.2	-4.8	-6.1

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200									23.9			
1300					19.9				42.0			
1400	31.3				45.2				60.2	26.9		
1500	58.9				67.2	24.9			77.0	45.5		
1600	81.7	36.6			86.7	49.0			92.9	63.2	30.7	
1700	103.0	63.3			105.3	71.0	29.3			79.9	48.8	
1800		85.8	41.6			90.3	53.4			96.1	66.5	37.2
1900		105.4	68.4	23.3			75.0	38.5			83.1	55.7
2000			89.6	52.6			93.6	62.0			98.7	72.8
2100			110.8	76.2				81.9				88.8
2200				96.7				100.1				104.7

1. **Enter Table 1 with slush/standing water depth and TO2 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -35 m/+35 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH											
	3 mm (0.12 INCHES)				6 mm (0.25 INCHES)				13 mm (0.50 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-13	-8	-3	0	-8	-3	0	0	0	0	0	0
80	-16	-11	-6	-1	-11	-6	-1	0	0	0	0	0
70	-19	-14	-9	-4	-15	-10	-5	0	-4	0	0	0
60	-22	-17	-12	-8	-19	-14	-9	-5	-11	-6	-1	0
50	-26	-21	-16	-12	-24	-19	-14	-9	-18	-13	-8	-4
40	-31	-26	-21	-16	-29	-24	-19	-15	-26	-21	-16	-12

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

ADVISORY INFORMATION

TO2 Dry Snow Takeoff

20% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-3.8	-5.2	-6.5	-7.8	-5.6	-6.9	-8.3	-9.5	-9.2	-10.6	-11.9	-13.2
80	-4.1	-5.5	-6.8	-8.1	-5.5	-6.9	-8.3	-9.5	-8.3	-9.6	-11.0	-12.2
70	-4.0	-5.4	-6.7	-7.9	-5.1	-6.4	-7.8	-9.0	-7.0	-8.3	-9.7	-10.9
60	-3.3	-4.7	-6.0	-7.3	-4.0	-5.4	-6.8	-8.0	-5.4	-6.7	-8.1	-9.3
50	-2.1	-3.4	-4.8	-6.0	-2.5	-3.9	-5.2	-6.4	-3.3	-4.6	-6.0	-7.2
40	-0.3	-1.7	-3.0	-4.3	-0.4	-1.8	-3.1	-4.4	-0.8	-2.1	-3.5	-4.7

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	52.2	30.1			55.2	34.2			58.4	39.3	20.4	
1400	78.3	55.6	33.3		79.8	58.3	37.3	18.4	81.1	61.3	42.1	24.9
1600	104.5	81.5	58.8	38.7	104.7	82.9	61.4	42.4	104.1	83.9	64.1	46.7
1800		107.9	84.7	64.3		107.8	86.0	66.6		107.1	86.7	68.7
2000			111.1	90.3			110.8	91.2			109.9	91.6

1. **Enter Table 1 with dry snow depth and TO2 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8	-3	0	0	-5	0	0	0	0	0	0	0
80	-10	-5	0	0	-7	-2	0	0	-2	0	0	0
70	-13	-8	-3	0	-10	-5	0	0	-5	0	0	0
60	-16	-11	-6	-1	-13	-8	-3	0	-8	-3	0	0
50	-18	-13	-8	-4	-16	-11	-6	-2	-12	-7	-2	0
40	-21	-16	-11	-7	-19	-14	-9	-5	-16	-11	-6	-1

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5.3	-6.4	-7.6	-8.7	-7.2	-8.4	-9.6	-10.7	-10.8	-12.0	-13.2	-14.2
80	-5.8	-7.0	-8.2	-9.2	-7.3	-8.5	-9.7	-10.7	-10.0	-11.2	-12.3	-13.4
70	-5.8	-7.0	-8.2	-9.3	-6.9	-8.1	-9.3	-10.3	-8.8	-10.0	-11.2	-12.2
60	-5.2	-6.4	-7.5	-8.6	-5.9	-7.0	-8.2	-9.3	-7.1	-8.3	-9.5	-10.5
50	-3.8	-5.0	-6.2	-7.2	-4.2	-5.4	-6.5	-7.6	-4.9	-6.1	-7.3	-8.3
40	-1.8	-2.9	-4.1	-5.2	-1.9	-3.1	-4.3	-5.3	-2.2	-3.4	-4.6	-5.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200									38.4			
1300	20.7				38.8				52.1	28.5		
1400	46.5				57.4	25.7			65.9	42.5		
1500	67.9	29.3			74.3	44.7			79.6	56.4	32.8	
1600	86.3	52.8			90.0	62.6	32.0		93.2	70.2	46.8	
1700	103.9	73.8	36.3		105.4	79.2	50.2			83.8	60.7	39.5
1800		91.8	59.9	23.1		94.8	67.9	40.6		97.3	74.4	53.4
1900			79.8	48.4			84.2	59.0			88.0	67.2
2000			96.8	70.0			99.4	75.8			101.5	80.9
2100				88.0				91.4				94.4
2200				105.6								

1. **Enter Table 1 with dry snow depth and TO2 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-9	-4	0	0	-5	0	0	0	0	0	0	0
80	-12	-7	-2	0	-9	-4	0	0	-2	0	0	0
70	-16	-11	-6	-2	-13	-8	-3	0	-6	-1	0	0
60	-21	-16	-11	-6	-17	-12	-7	-3	-11	-6	-1	0
50	-25	-20	-15	-11	-22	-17	-12	-7	-16	-11	-6	-1
40	-30	-25	-20	-16	-27	-22	-17	-12	-21	-16	-11	-7

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).**

   V1 not to exceed VR.

ADVISORY INFORMATION

TO2 Wet Snow Takeoff

20% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-4.4	-5.8	-7.1	-8.3	-6.3	-7.6	-8.9	-10.1	-11.8	-13.2	-14.5	-15.6
80	-4.6	-5.9	-7.3	-8.4	-6.1	-7.4	-8.7	-9.9	-10.3	-11.6	-12.9	-14.1
70	-4.4	-5.7	-7.0	-8.2	-5.4	-6.7	-8.0	-9.2	-8.4	-9.8	-11.1	-12.2
60	-3.4	-4.8	-6.1	-7.3	-4.1	-5.4	-6.8	-7.9	-6.1	-7.4	-8.8	-9.9
50	-2.0	-3.3	-4.6	-5.8	-2.3	-3.6	-4.9	-6.1	-3.3	-4.6	-5.9	-7.2
40	0.0	-1.1	-2.4	-3.6	0.0	-1.2	-2.5	-3.7	-0.1	-1.5	-2.8	-3.9

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200	50.9	28.4			53.1	31.2			56.4	36.4		
1400	77.6	54.5	31.9		78.8	56.4	34.5		80.1	59.7	39.5	21.4
1600	104.9	81.2	58.0	37.6	104.9	82.2	59.9	40.0	103.9	83.2	62.8	44.6
1800		108.6	84.8	63.8		108.4	85.6	65.4		107.1	86.3	67.9
2000			112.1	90.7			111.8	91.3			110.2	91.5

1. **Enter Table 1 with wet snow depth and TO2 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-7	-2	0	0	-4	0	0	0	0	0	0	0
80	-11	-6	-1	0	-7	-2	0	0	0	0	0	0
70	-13	-8	-3	0	-10	-5	0	0	-2	0	0	0
60	-16	-11	-6	-1	-13	-8	-3	0	-7	-2	0	0
50	-19	-14	-9	-5	-18	-13	-8	-3	-13	-8	-3	0
40	-24	-19	-14	-9	-23	-18	-13	-8	-20	-15	-10	-6

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-5.8	-7.1	-8.3	-9.5	-7.9	-9.2	-10.5	-11.7	-13.9	-15.1	-16.5	-17.6
80	-6.3	-7.5	-8.8	-10.0	-7.8	-9.1	-10.4	-11.5	-12.3	-13.6	-14.9	-16.1
70	-6.2	-7.4	-8.8	-9.9	-7.2	-8.5	-9.8	-10.9	-10.3	-11.7	-12.9	-14.1
60	-5.4	-6.6	-7.9	-9.1	-5.9	-7.2	-8.5	-9.7	-7.9	-9.3	-10.5	-11.7
50	-3.8	-5.1	-6.4	-7.5	-4.0	-5.4	-6.6	-7.8	-5.1	-6.4	-7.7	-8.8
40	-1.5	-2.8	-4.1	-5.2	-1.5	-2.8	-4.1	-5.3	-1.8	-3.1	-4.4	-5.5

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200									27.8			
1300					24.2				44.6			
1400	38.6				49.2				61.4	33.0		
1500	63.8	18.9			69.7	33.6			76.7	50.4		
1600	84.2	47.1			87.3	55.9			91.1	66.6	39.0	
1700	103.1	71.2	28.4		104.1	75.9	40.8			81.7	55.9	30.3
1800		90.6	56.2	18.6		93.1	63.4	28.7		96.2	71.8	47.7
1900			78.6	43.5			82.3	53.2			86.7	64.3
2000			96.5	68.3			98.4	73.3			100.6	79.5
2100				87.7				90.4				93.7
2200				106.3								

1. Enter Table 1 with wet snow depth and TO2 dry field/obstacle limit weight to obtain wet snow weight adjustment.
2. Adjust field length available by -30 m/+30 m for every 10°C above/below 0°C.
3. Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).
4. Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH											
	5 mm (0.20 INCHES)				13 mm (0.50 INCHES)				30 mm (1.18 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8	-3	0	0	-4	0	0	0	0	0	0	0
80	-13	-8	-3	0	-8	-3	0	0	0	0	0	0
70	-17	-12	-7	-2	-13	-8	-3	0	-2	0	0	0
60	-21	-16	-11	-7	-18	-13	-8	-4	-9	-4	0	0
50	-27	-22	-17	-12	-24	-19	-14	-10	-18	-13	-8	-4
40	-33	-28	-23	-19	-32	-27	-22	-17	-28	-23	-18	-14

1. Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

V1 not to exceed VR.

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

Maximum Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-0.3	-1.1	-1.9	-2.6	-1.7	-2.5	-3.3	-4.0	-8.9	-9.7	-10.5	-11.2
80	-0.8	-1.5	-2.4	-3.0	-2.4	-3.3	-4.0	-4.8	-8.8	-9.6	-10.3	-11.1
70	-0.9	-1.6	-2.4	-3.1	-2.8	-3.6	-4.4	-5.1	-8.2	-9.0	-9.8	-10.5
60	-0.5	-1.3	-2.1	-2.8	-2.5	-3.3	-4.1	-4.8	-6.9	-7.8	-8.5	-9.3
50	0.0	-0.8	-1.6	-2.3	-1.6	-2.4	-3.2	-3.9	-5.1	-5.9	-6.7	-7.4
40	0.0	-0.8	-1.6	-2.4	-0.2	-1.0	-1.8	-2.5	-2.6	-3.4	-4.2	-4.9

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200		62.1	34.4	7.2	51.0	27.1						
1400		95.7	71.5	47.5	79.9	55.0	30.8					
1600			105.5	83.6	109.4	83.8	58.7	36.8	30.5			
1800				117.8		113.0	87.7	64.9	42.9			
2000							117.2	94.1	55.5	33.4		
2200									69.4	45.7		
2400									84.9	58.6	36.3	
2600									102.0	72.8	48.6	
2800										88.9	61.8	41.3
3000										106.1	76.3	53.9
3200											92.9	67.6
3400												82.9
3600												100.2

1. **Enter Table 1 with reported braking action and TO2 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -25 m/+25 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -30 m/+30 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -55 m/+55 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-8	-6	-3	-1	-12	-10	-7	-5	-29	-27	-24	-22
80	-9	-7	-4	-2	-14	-11	-9	-7	-33	-30	-28	-25
70	-10	-8	-5	-3	-16	-13	-11	-8	-35	-33	-30	-28
60	-11	-9	-6	-4	-18	-15	-13	-10	-38	-35	-33	-30
50	-12	-9	-7	-5	-20	-17	-15	-13	-40	-37	-35	-32
40	-12	-10	-7	-5	-22	-19	-17	-15	-41	-39	-36	-34

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-1.9	-2.7	-3.4	-4.2	-3.4	-4.2	-5.0	-5.7	-12.1	-12.9	-13.7	-14.4
80	-2.2	-3.0	-3.8	-4.5	-4.3	-5.1	-5.9	-6.6	-12.2	-12.9	-13.7	-14.4
70	-2.3	-3.0	-3.9	-4.5	-4.7	-5.5	-6.3	-7.0	-11.4	-12.2	-13.0	-13.7
60	-1.8	-2.5	-3.4	-4.1	-4.4	-5.2	-6.0	-6.7	-9.7	-10.4	-11.2	-12.0
50	-0.8	-1.6	-2.4	-3.1	-3.3	-4.1	-4.9	-5.6	-6.9	-7.7	-8.5	-9.2
40	0.0	-0.9	-1.6	-2.4	-1.6	-2.4	-3.2	-3.9	-3.2	-4.0	-4.8	-5.5

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
1200		39.9										
1300		65.6	9.3									
1400		88.4	53.2		35.8							
1500		106.4	79.6	41.3	65.9	16.0						
1600			99.0	73.5	88.0	46.6						
1700				94.0	107.1	73.8	23.1					
1800						94.2	56.4					
1900							80.9	40.4				
2000							101.0	69.3				
2100								90.6				
3300									62.8			
3400									85.4			
3500									100.3			
3700										68.5		
3800										88.9		
3900										103.8		
4100											74.7	
4200											92.3	
4400												64.0
4500												86.0

1. **Enter Table 1 with reported braking action and TO2 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -25 m/+25 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -30 m/+30 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -80 m/+80 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION											
	GOOD				MEDIUM				POOR			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14500	S.L.	5000	10000	14500	S.L.	5000	10000	14500
90	-10	-5	0	0	-15	-10	-5	0	-44	-39	-34	-30
80	-12	-7	-2	0	-18	-13	-8	-3	-50	-45	-40	-35
70	-13	-8	-3	0	-21	-16	-11	-6	-55	-50	-45	-40
60	-14	-9	-4	0	-24	-19	-14	-9	-59	-54	-49	-45
50	-15	-10	-5	0	-27	-22	-17	-13	-63	-58	-53	-49
40	-16	-11	-6	-1	-31	-26	-21	-16	-66	-61	-56	-52

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

TO2 Takeoff %N1

20% Thrust Reduction

Based on bleed packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	77.5	77.9	78.4	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.3	77.9	77.6	76.7	75.8	75.4	75.5	75.5
55	79.0	79.3	79.7	79.8	79.9	79.9	79.8	79.9	79.9	79.9	79.7	79.3	78.9	78.0	77.1	76.0	74.9	74.9
50	80.5	80.9	81.2	81.2	81.2	81.2	81.1	81.2	81.1	81.2	80.9	80.6	80.2	79.3	78.4	77.2	76.1	75.6
45	81.9	82.3	82.7	82.6	82.5	82.5	82.4	82.4	82.3	82.4	82.2	81.8	81.4	80.6	79.7	78.5	77.4	76.9
40	83.1	83.6	84.0	83.9	83.9	83.8	83.7	83.6	83.6	83.5	83.3	82.9	82.6	81.7	80.9	79.8	78.7	78.1
35	84.3	84.8	85.2	85.2	85.2	85.1	84.9	84.8	84.6	84.3	84.2	83.9	83.7	82.8	82.0	81.0	79.9	79.4
30	84.0	85.2	86.4	86.3	86.3	86.1	85.9	85.7	85.4	85.1	84.9	84.7	84.5	83.8	83.0	82.1	81.1	80.6
25	83.3	84.5	85.7	86.2	86.7	86.9	86.7	86.6	86.3	86.0	85.7	85.5	85.3	84.6	83.8	83.0	82.2	81.8
20	82.5	83.7	84.9	85.3	85.9	86.4	86.9	87.1	87.0	86.7	86.4	86.2	86.1	85.4	84.7	83.9	83.1	82.7
15	81.8	83.0	84.1	84.6	85.1	85.7	86.1	86.4	86.5	86.6	86.6	86.5	86.3	85.8	85.2	84.6	83.8	83.4
10	81.0	82.2	83.4	83.8	84.4	84.9	85.4	85.6	85.7	85.8	86.0	86.4	86.6	86.0	85.3	84.8	84.4	84.0
5	80.3	81.5	82.6	83.1	83.6	84.1	84.6	84.9	84.9	85.0	85.2	85.7	85.8	85.7	85.5	85.3	84.7	84.4
0	79.5	80.7	81.9	82.3	82.9	83.4	83.8	84.1	84.2	84.3	84.5	84.9	85.0	84.9	84.7	84.7	84.6	84.6
-5	78.7	79.9	81.1	81.6	82.1	82.6	83.0	83.3	83.4	83.5	83.7	84.1	84.3	84.1	84.0	83.9	83.9	83.8
-10	78.0	79.2	80.3	80.8	81.4	81.8	82.3	82.5	82.6	82.7	82.9	83.3	83.5	83.3	83.2	83.1	83.1	83.1
-15	77.2	78.4	79.6	80.0	80.6	81.0	81.4	81.7	81.8	81.9	82.1	82.5	82.7	82.6	82.4	82.3	82.3	82.3
-20	76.5	77.6	78.8	79.3	79.8	80.2	80.6	80.9	81.0	81.1	81.3	81.8	81.9	81.8	81.6	81.6	81.5	81.5
-25	75.7	76.9	78.0	78.5	79.0	79.5	79.8	80.1	80.2	80.3	80.6	81.0	81.1	81.0	80.9	80.8	80.8	80.7
-30	75.0	76.1	77.2	77.7	78.3	78.7	79.1	79.3	79.4	79.5	79.8	80.2	80.3	80.2	80.1	80.0	80.0	80.0
-35	74.2	75.3	76.4	76.9	77.5	77.9	78.3	78.5	78.6	78.7	79.0	79.4	79.5	79.4	79.3	79.2	79.2	79.2
-40	73.5	74.6	75.6	76.1	76.7	77.1	77.4	77.7	77.8	77.9	78.1	78.6	78.7	78.6	78.4	78.4	78.4	78.4
-45	72.7	73.8	74.8	75.3	75.9	76.3	76.6	76.9	77.0	77.1	77.3	77.7	77.8	77.7	77.6	77.6	77.6	77.6
-50	71.9	73.0	74.0	74.5	75.0	75.5	75.8	76.1	76.1	76.3	76.5	76.9	76.9	76.9	76.8	76.8	76.8	76.7

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.7	0.8	0.8	0.9	1.0	0.9	1.0	1.0	1.1	1.2	1.4	1.4	1.6	1.8	2.0	2.0	2.0	2.1
ENGINE ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.9	-0.9	-0.4	0.0	0.0	0.0

TO2 Assumed Temperature Reduced Thrust

Maximum Assumed Temperature (Table 1 of 3)

Based on 25% Takeoff Thrust Reduction

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	66	67	68	68	68	68	68	68	68	68	68	67	66	63	61	59	58	59
55	66	67	68	68	68	68	68	68	68	68	68	67	66	63	61	58	55	54
50	66	67	68	68	68	68	68	68	68	68	68	67	66	63	61	58	55	53
45	66	67	68	68	68	68	68	68	68	68	68	67	66	63	61	58	55	53
40	63	63	64	64	64	64	64	64	64	64	64	63	63	63	61	58	55	53
35	58	58	59	59	59	59	59	60	60	61	60	59	59	58	58	57	55	53
30	58	56	54	54	54	55	56	56	56	57	56	56	56	54	54	53	52	52
25	58	56	54	53	52	51	52	52	53	53	52	52	52	51	50	49	49	48
20	58	56	54	52	52	51	50	49	49	49	48	48	48	47	46	46	45	44
15	58	56	54	53	52	51	50	49	48	46	44	44	43	42	41	41	40	39
10	58	56	54	53	52	51	50	49	47	46	44	42	39	38	36	35	34	34
5	58	56	54	53	52	51	50	49	47	46	44	42	39	37	33	32	31	30
0	58	56	54	53	52	51	50	49	47	46	43	42	39	37	33	31	28	27
-5 & BELOW	58	56	54	53	52	51	50	49	47	46	43	42	39	37	33	31	28	27

Takeoff %N1 (Table 2 of 3)

Based on engine bleed for packs on and engine anti-ice off

ASSUMED TEMP (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
75	77.0	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1	77.1
70	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.6	76.6	76.6	76.6	76.6	76.6
65	76.3	76.7	77.1	77.2	77.3	77.3	77.2	77.2	77.2	77.2	77.0	76.7	76.3	76.0	76.0	76.0	76.0	76.0
60	77.5	77.9	78.4	78.5	78.5	78.5	78.5	78.5	78.5	78.5	78.3	77.9	77.6	76.7	75.8	75.4	75.5	75.5
55	79.0	79.3	79.7	79.8	79.9	79.9	79.8	79.9	79.9	79.9	79.7	79.3	78.9	78.0	77.1	76.0	74.9	74.9
50	80.5	80.9	81.2	81.2	81.2	81.2	81.1	81.2	81.1	81.2	80.9	80.6	80.2	79.3	78.4	77.2	76.1	75.6
45	81.9	82.3	82.7	82.6	82.5	82.5	82.4	82.4	82.3	82.4	82.2	81.8	81.4	80.6	79.7	78.5	77.4	76.9
40	83.1	83.6	84.0	83.9	83.9	83.8	83.7	83.6	83.6	83.5	83.3	82.9	82.6	81.7	80.9	79.8	78.7	78.1
35	84.3	84.8	85.2	85.2	85.2	85.1	84.9	84.8	84.6	84.3	84.2	83.9	83.7	82.8	82.0	81.0	79.9	79.4
30	84.0	85.2	86.4	86.3	86.3	86.1	85.9	85.7	85.4	85.1	84.9	84.7	84.5	83.8	83.0	82.1	81.1	80.6
25	83.3	84.5	85.7	86.2	86.7	86.9	86.7	86.6	86.3	86.0	85.7	85.5	85.3	84.6	83.8	83.0	82.2	81.8
20	82.5	83.7	84.9	85.3	85.9	86.4	86.9	87.1	87.0	86.7	86.4	86.2	86.1	85.4	84.7	83.9	83.1	82.7
15	81.8	83.0	84.1	84.6	85.1	85.7	86.1	86.4	86.5	86.6	86.6	86.5	86.3	85.8	85.2	84.6	83.8	83.4
10	81.0	82.2	83.4	83.8	84.4	84.9	85.4	85.6	85.7	85.8	86.0	86.4	86.6	86.0	85.3	84.8	84.4	84.0
5	80.3	81.5	82.6	83.1	83.6	84.1	84.6	84.9	84.9	85.0	85.2	85.7	85.8	85.7	85.5	85.3	84.7	84.4
0	79.5	80.7	81.9	82.3	82.9	83.4	83.8	84.1	84.2	84.3	84.5	84.9	85.0	84.9	84.7	84.7	84.6	84.6
-5	78.7	79.9	81.1	81.6	82.1	82.6	83.0	83.3	83.4	83.5	83.7	84.1	84.3	84.1	84.0	83.9	83.9	83.8
-20	76.5	77.6	78.8	79.3	79.8	80.2	80.6	80.9	81.0	81.1	81.3	81.8	81.9	81.8	81.6	81.6	81.5	81.5
-40	73.5	74.6	75.6	76.1	76.7	77.1	77.4	77.7	77.8	77.9	78.1	78.6	78.7	78.6	78.4	78.4	78.4	78.4
MINIMUM ASSUMED TEMP (°C)	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2	1

TO2 Assumed Temperature Reduced Thrust
%N1 Adjustment for Temperature Difference (Table 3 of 3)

ASSUMED TEMP MINUS OAT (°C)	OUTSIDE AIR TEMPERATURE (°C)													
	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
115	7.2													
110	7.2													
105	7.2													
100	7.2													
95	6.9	7.4												
90	5.1	7.4												
85	3.4	7.4												
80	1.7	7.4												
75	0.1	7.2	7.7											
70	0.0	5.3	7.7	7.7										
65	0.0	3.5	7.7	7.7	7.8									
60	0.0	1.8	7.5	7.5	7.4	7.4								
55	0.0	0.1	7.0	6.9	6.9	6.8	6.8							
50	0.0	0.0	5.5	6.4	6.3	6.3	6.2	6.0						
45	0.0	0.0	3.7	5.6	5.8	5.7	5.7	5.5	5.3					
40	0.0	0.0	1.9	3.7	5.2	5.1	5.1	4.9	4.8	4.6				
35		0.0	0.1	1.9	3.8	4.6	4.5	4.4	4.2	4.1	3.9			
30		0.0	0.0	0.1	2.0	3.9	3.9	3.8	3.7	3.6	3.5	2.0		
25		0.0	0.0	0.0	0.2	2.0	3.3	3.2	3.1	3.0	2.9	2.0	0.2	
20		0.0	0.0	0.0	0.0	0.2	2.1	2.6	2.5	2.4	2.4	2.0	0.2	0.0
15			0.0	0.0	0.0	0.0	0.2	2.0	1.9	1.8	1.8	1.7	0.2	0.0
10			0.0	0.0	0.0	0.0	0.0	0.3	1.3	1.2	1.2	1.2	0.2	0.0
5			0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.6	0.6	0.2	0.0
0			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

1. **Determine Maximum Assumed Temperature allowed from Table 1.**
2. **Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).**
3. **Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.**
4. **Subtract %N1 adjustment from Maximum %N1 in Table 2.**

Max Climb %N1

Based on engine bleed for packs on and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KIAS OR MACH)											
	0	5	10	15	20	25	30	33	35	37	39	41
	280	280	280	280	280	280	280	0.78	0.78	0.78	0.78	0.78
60	82.2	82.7	85.2	87.2	89.4	91.3	94.0	95.5	96.5	96.9	96.3	95.6
55	83.2	83.0	84.5	86.5	88.8	90.6	93.3	94.8	95.8	96.1	95.5	94.9
50	84.1	84.0	84.0	85.8	88.1	89.9	92.6	94.0	95.1	95.4	94.8	94.2
45	85.1	85.0	84.9	85.2	87.4	89.2	91.9	93.3	94.3	94.7	94.1	93.5
40	86.1	86.1	86.1	85.5	86.7	88.5	91.2	92.6	93.6	93.9	93.3	92.7
35	86.8	87.1	87.1	86.6	86.4	87.8	90.4	91.8	92.9	93.2	92.6	92.0
30	86.0	88.0	88.1	87.7	87.1	87.1	89.7	91.1	92.1	92.4	91.8	91.2
25	85.3	88.1	89.0	88.6	88.0	87.8	88.9	90.3	91.3	91.6	91.1	90.5
20	84.6	87.4	90.0	89.6	89.0	88.7	89.4	89.8	90.6	90.9	90.3	89.7
15	83.8	86.6	89.4	90.6	90.0	89.8	90.2	90.5	90.3	90.1	89.5	88.9
10	83.1	85.8	88.6	91.0	91.1	90.9	91.1	91.3	91.0	90.3	89.7	89.2
5	82.3	85.1	87.9	90.2	92.2	91.9	91.9	92.0	91.8	91.1	90.7	90.1
0	81.5	84.3	87.1	89.4	91.5	92.9	92.6	92.6	92.3	91.8	91.3	90.6
-5	80.8	83.5	86.3	88.7	90.7	92.7	93.4	93.4	93.1	92.4	91.9	91.2
-10	80.0	82.7	85.5	87.9	89.9	91.9	93.6	94.3	94.0	93.2	92.6	91.8
-15	79.3	81.9	84.8	87.1	89.2	91.0	92.8	94.1	94.8	94.1	93.5	92.7
-20	78.5	81.1	83.9	86.4	88.4	90.2	91.9	93.2	94.4	94.5	93.9	93.1
-25	77.7	80.3	83.1	85.6	87.6	89.3	91.0	92.3	93.5	93.6	93.0	92.2
-30	76.9	79.5	82.2	84.7	86.8	88.5	90.1	91.4	92.6	92.7	92.1	91.3
-35	76.1	78.7	81.4	83.9	85.9	87.6	89.2	90.5	91.6	91.7	91.2	90.4
-40	75.3	77.8	80.5	83.0	85.1	86.7	88.3	89.6	90.7	90.8	90.3	89.5

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)											
	0	5	10	15	20	25	30	33	35	37	39	41
ENGINE ANTI-ICE	0.0	0.0	-1.0	-1.0	-1.1	-0.8	-1.0	-1.3	-1.8	-2.0	-2.0	-1.9
ENGINE & WING ANTI-ICE	0.0	0.0	-2.0	-2.0	-2.3	-2.1	-2.6	-3.2	-4.0	-4.1	-4.1	-4.0

Go-Around %N1

Based on engine bleed for packs on and anti-ice off

REPORTED OAT (°C)	TAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
59	60	85.5	86.0	86.4	86.5	86.6	86.6	86.6	86.6	86.6	86.7	86.4	86.1	85.7	84.8	83.8	82.7	81.6	81.0
54	55	87.0	87.4	87.8	87.8	87.9	87.9	87.9	87.9	87.9	88.0	87.7	87.4	87.0	86.1	85.2	84.0	82.9	82.3
49	50	88.5	88.9	89.2	89.2	89.2	89.2	89.1	89.2	89.2	89.2	89.0	88.6	88.3	87.4	86.4	85.3	84.2	83.6
44	45	89.8	90.3	90.7	90.7	90.6	90.6	90.5	90.4	90.4	90.5	90.2	89.9	89.5	88.6	87.7	86.6	85.5	84.9
39	40	91.1	91.6	92.1	92.1	92.0	92.0	91.9	91.8	91.7	91.6	91.4	91.1	90.7	89.8	88.9	87.8	86.7	86.1
34	35	92.4	92.9	93.4	93.4	93.4	93.3	93.1	92.9	92.7	92.4	92.2	92.0	91.8	90.9	90.0	89.0	87.9	87.4
29	30	91.7	93.0	94.3	94.5	94.5	94.3	94.1	93.9	93.6	93.3	93.0	92.8	92.6	91.8	91.0	90.1	89.1	88.7
24	25	90.9	92.2	93.5	94.0	94.6	95.1	95.0	94.8	94.5	94.2	93.9	93.7	93.5	92.7	91.9	91.1	90.2	89.8
19	20	90.1	91.4	92.7	93.1	93.7	94.3	94.8	95.2	95.3	95.0	94.6	94.4	94.3	93.6	92.8	92.0	91.2	90.8
14	15	89.3	90.5	91.8	92.3	92.9	93.5	94.0	94.3	94.7	95.1	95.6	95.6	95.2	94.2	93.3	92.7	91.9	91.5
9	10	88.5	89.7	91.0	91.5	92.1	92.6	93.1	93.5	93.8	94.2	94.8	95.5	96.1	95.7	94.6	93.5	92.5	92.2
4	5	87.6	88.9	90.2	90.7	91.3	91.8	92.3	92.7	93.0	93.4	93.9	94.7	95.3	95.1	95.0	94.9	94.1	93.6
-1	0	86.8	88.1	89.3	89.8	90.4	91.0	91.4	91.8	92.1	92.5	93.1	93.9	94.4	94.3	94.1	94.0	94.0	94.0
-6	-5	85.9	87.2	88.5	89.0	89.6	90.1	90.6	90.9	91.2	91.6	92.2	93.0	93.5	93.4	93.3	93.2	93.1	93.1
-11	-10	85.1	86.4	87.7	88.2	88.8	89.3	89.7	90.0	90.4	90.7	91.4	92.1	92.7	92.6	92.4	92.3	92.2	92.2
-16	-15	84.3	85.6	86.8	87.4	87.9	88.4	88.8	89.2	89.5	89.9	90.5	91.3	91.9	91.7	91.6	91.5	91.4	91.3
-21	-20	83.5	84.8	86.0	86.5	87.1	87.6	88.0	88.3	88.6	89.0	89.7	90.4	91.0	90.9	90.7	90.6	90.5	90.5
-26	-25	82.7	83.9	85.1	85.7	86.2	86.7	87.1	87.4	87.8	88.2	88.8	89.6	90.2	90.0	89.9	89.8	89.7	89.7
-31	-30	81.9	83.1	84.3	84.8	85.4	85.8	86.2	86.5	86.9	87.3	87.9	88.7	89.3	89.2	89.0	88.9	88.9	88.8
-36	-35	81.0	82.2	83.4	84.0	84.5	85.0	85.4	85.7	86.0	86.4	87.0	87.8	88.4	88.3	88.1	88.1	88.0	87.9
-41	-40	80.2	81.4	82.6	83.1	83.7	84.1	84.5	84.8	85.1	85.5	86.1	86.9	87.4	87.4	87.2	87.2	87.1	87.1
-46	-45	79.3	80.5	81.7	82.2	82.8	83.2	83.6	83.9	84.2	84.6	85.2	86.0	86.5	86.4	86.3	86.3	86.2	86.2
-51	-50	78.5	79.6	80.8	81.3	81.9	82.3	82.7	83.0	83.3	83.7	84.3	85.0	85.5	85.5	85.4	85.4	85.3	85.3

%N1 Adjustment forEngine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.7	0.8	0.8	0.9	1.0	0.9	1.0	1.0	1.1	1.2	1.4	1.4	1.6	1.8	2.0	2.0	2.0	2.1
A/C HIGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINE & WING ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	-1.7	-1.9	-1.9	-2.0	-2.0	-2.0
ENGINE & WING ANTI-ICE*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.1	-2.5	-2.7	-2.9	-2.9	-2.9	-2.9

***Single Bleed Source**

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

CLIMB (280/.76)

Flaps Up, Set Max Climb Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG) 40	50	60	70	80	90
40000	**PITCH ATT**	**4.0**	**4.0**	**4.5**			
	V/S (FT/MIN)	1700	1100	600			
	ANGLE OF ATTACK	2.0	2.7	3.5			
30000	**PITCH ATT**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**
	V/S (FT/MIN)	2500	1900	1500	1100	800	600
	ANGLE OF ATTACK	0.9	1.4	1.9	2.5	3.0	3.5
20000	**PITCH ATT**	**7.0**	**6.5**	**6.0**	**6.0**	**6.0**	**6.0**
	V/S (FT/MIN)	4000	3100	2500	2100	1700	1300
	ANGLE OF ATTACK	1.0	1.6	2.2	2.8	3.4	4.0
10000	**PITCH ATT**	**11.0**	**9.5**	**8.5**	**8.0**	**7.5**	**7.5**
	V/S (FT/MIN)	5500	4300	3500	2900	2400	2100
	ANGLE OF ATTACK	1.0	1.7	2.3	2.8	3.5	4.1
SEA LEVEL	**PITCH ATT**	**15.0**	**12.5**	**11.0**	**10.0**	**9.5**	**9.5**
	V/S (FT/MIN)	6800	5300	4300	3600	3100	2600
	ANGLE OF ATTACK	1.0	1.6	2.2	2.8	3.3	3.9

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

CRUISE (.76/280)

Flaps Up, Set Thrust for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG) 40	50	60	70	80	90
40000	**PITCH ATT**	**2.0**	**2.5**	**3.5**			
	%N1	**78.4**	**80.9**	**84.5**			
	ANGLE OF ATTACK	2.0	2.7	3.5			
35000	**PITCH ATT**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	
	%N1	**76.8**	**78.2**	**80.0**	**82.5**	**85.7**	
	ANGLE OF ATTACK	1.3	1.9	2.5	3.1	3.7	
30000	**PITCH ATT**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**
	%N1	**76.2**	**77.1**	**78.3**	**79.8**	**81.6**	**84.2**
	ANGLE OF ATTACK	0.9	1.4	2.0	2.5	3.0	3.5
25000	**PITCH ATT**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**4.0**
	%N1	**72.2**	**73.0**	**74.3**	**75.7**	**77.6**	**79.8**
	ANGLE OF ATTACK	1.0	1.5	2.1	2.7	3.2	3.8
20000	**PITCH ATT**	**1.0**	**1.5**	**2.0**	**3.0**	**3.5**	**4.0**
	%N1	**68.1**	**69.0**	**70.1**	**71.5**	**73.2**	**75.4**
	ANGLE OF ATTACK	1.1	1.6	2.2	2.8	3.4	4.0
15000	**PITCH ATT**	**1.0**	**1.5**	**2.5**	**3.0**	**3.5**	**4.0**
	%N1	**64.3**	**65.0**	**66.1**	**67.3**	**68.9**	**70.9**
	ANGLE OF ATTACK	1.1	1.7	2.3	2.9	3.5	4.1

Flight With Unreliable Airspeed/ Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

DESCENT (.76/280)
Flaps Up, Set Idle Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		40	50	60	70	80	90
40000	**PITCH ATT**	**-1.0**	**0.0**	**0.5**	**1.5**	**1.5**	**1.0**
	V/S (FT/MIN)	-2400	-2200	-2200	-2300	-2800	-3600
	ANGLE OF ATTACK	2.0	2.8	3.5	4.3	5.0	5.8
30000	**PITCH ATT**	**-3.0**	**-2.0**	**-1.0**	**0.0**	**0.5**	**1.0**
	V/S (FT/MIN)	-3000	-2500	-2200	-2000	-1900	-1900
	ANGLE OF ATTACK	0.9	1.4	1.9	2.5	3.0	3.5
20000	**PITCH ATT**	**-3.5**	**-2.0**	**-1.0**	**0.0**	**0.5**	**1.5**
	V/S (FT/MIN)	-2900	-2400	-2100	-1900	-1800	-1700
	ANGLE OF ATTACK	1.0	1.6	2.3	2.8	3.4	4.0
10000	**PITCH ATT**	**-3.5**	**-2.0**	**-1.0**	**0.0**	**0.5**	**1.5**
	V/S (FT/MIN)	-2700	-2200	-1900	-1800	-1600	-1600
	ANGLE OF ATTACK	1.1	1.7	2.3	2.9	3.5	4.1
SEA LEVEL	**PITCH ATT**	**-4.0**	**-2.5**	**-1.5**	**-0.5**	**0.5**	**1.0**
	V/S (FT/MIN)	-2400	-2000	-1800	-1600	-1500	-1400
	ANGLE OF ATTACK	1.0	1.6	2.2	2.8	3.3	3.9

HOLDING (VREF40 + 70)
Flaps Up, Set Thrust for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		40	50	60	70	80	90
15000	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.0**	**5.5**	**5.0**
	%N1	**49.9**	**54.5**	**59.1**	**63.2**	**66.8**	**70.1**
	KIAS	178	191	206	224	240	254
	ANGLE OF ATTACK	4.7	5.1	5.3	5.3	5.3	5.3
10000	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**5.5**	**5.5**	**5.5**
	%N1	**46.7**	**51.0**	**55.1**	**59.0**	**62.6**	**65.7**
	KIAS	178	191	206	222	238	253
	ANGLE OF ATTACK	4.7	5.1	5.3	5.3	5.3	5.3
5000	**PITCH ATT**	**5.0**	**5.0**	**5.5**	**5.5**	**5.5**	**5.5**
	%N1	**43.7**	**47.8**	**51.7**	**55.3**	**58.8**	**61.9**
	KIAS	178	191	204	222	237	251
	ANGLE OF ATTACK	4.8	5.2	5.5	5.3	5.3	5.3

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

TERMINAL AREA (5000 FT)

Set Thrust for Level Flight

FLAP/GEAR POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS UP (GEAR UP) (VREF40+70)	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.5**	**6.5**
	%N1	**43.0**	**47.1**	**50.9**	**54.5**	**57.9**	**61.1**
	KIAS	176	189	201	211	223	235
	ANGLE OF ATTACK	4.7	5.2	5.6	6.0	6.3	6.3
FLAPS 1 (GEAR UP) (VREF40+50)	**PITCH ATT**	**4.5**	**5.0**	**5.5**	**6.0**	**6.0**	**6.0**
	%N1	**45.1**	**49.4**	**53.4**	**57.0**	**60.6**	**64.1**
	KIAS	156	169	181	191	203	215
	ANGLE OF ATTACK	4.7	5.1	5.5	5.8	6.0	6.0
FLAPS 5 (GEAR UP) (VREF40+30)	**PITCH ATT**	**5.5**	**5.5**	**6.0**	**6.5**	**6.5**	**6.0**
	%N1	**44.7**	**49.4**	**53.6**	**57.4**	**61.2**	**64.7**
	KIAS	136	149	161	171	183	195
	ANGLE OF ATTACK	5.3	5.7	6.0	6.3	6.3	6.2
FLAPS 15 (GEAR DOWN) (VREF40+20)	**PITCH ATT**	**5.0**	**5.0**	**5.5**	**6.0**	**5.5**	**5.5**
	%N1	**50.2**	**55.3**	**60.1**	**64.6**	**68.6**	**72.4**
	KIAS	126	139	151	161	173	185
	ANGLE OF ATTACK	4.9	5.2	5.5	5.8	5.7	5.4

FINAL APPROACH (1500 FT)

Gear Down, Set Thrust for 3° Glideslope

FLAP POSITION		WEIGHT (1000 KG)					
		40	50	60	70	80	90
FLAPS 15 (VREF15+10)	**PITCH ATT**	**1.5**	**2.0**	**2.0**	**2.0**	**2.5**	**2.5**
	%N1	**36.0**	**39.6**	**42.9**	**45.6**	**48.4**	**51.0**
	KIAS	127	141	154	164	175	185
	ANGLE OF ATTACK	4.6	4.8	4.9	5.2	5.3	5.3
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**1.0**	**1.0**	**1.5**	**1.5**	**1.5**
	%N1	**40.8**	**45.1**	**48.9**	**52.3**	**55.4**	**58.4**
	KIAS	120	134	145	155	165	175
	ANGLE OF ATTACK	3.7	3.9	4.1	4.4	4.5	4.5
FLAPS 40 (VREF40+10)	**PITCH ATT**	**-0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**-0.5**
	%N1	**45.6**	**50.5**	**54.7**	**58.5**	**62.5**	**66.4**
	KIAS	116	129	141	151	163	175
	ANGLE OF ATTACK	2.5	2.8	2.9	3.1	2.9	2.5

Flap placard speed exceeded in shaded area.

Flight With Unreliable Airspeed/ Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

GO-AROUND

Flaps 15, Gear Up, Set Go-Around Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		40	50	60	70	80	90
10000	**PITCH ATT**	**22.5**	**17.5**	**14.5**	**12.5**	**11.0**	**9.5**
	V/S (FT/MIN)	4600	3700	3000	2400	2000	1700
	KIAS	127	141	153	163	175	187
	ANGLE OF ATTACK	4.3	4.8	5.0	5.4	5.4	5.2
5000	**PITCH ATT**	**26.0**	**20.5**	**17.0**	**15.0**	**13.0**	**11.0**
	V/S (FT/MIN)	5200	4200	3500	2900	2400	2100
	KIAS	126	140	152	162	174	186
	ANGLE OF ATTACK	4.1	4.8	5.1	5.4	5.5	5.3
SEA LEVEL	**PITCH ATT**	**30.0**	**23.5**	**19.5**	**17.0**	**14.5**	**12.5**
	V/S (FT/MIN)	5700	4600	3800	3200	2800	2400
	KIAS	126	139	151	161	173	185
	ANGLE OF ATTACK	3.8	4.6	5.1	5.5	5.5	5.3

Performance Inflight Chapter PI
All Engine Section 31

Long Range Cruise Maximum Operating Altitude
Max Cruise Thrust
ISA + 10°C and Below

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
85	33500	-12	35000*	35000*	35000*	34200	32600
80	34800	-15	36200*	36200*	36200*	35500	33900
75	36200	-18	37400*	37400*	37400*	36800	35200
70	37600	-18	38700*	38700*	38700*	38200	36700
65	39100	-18	40000*	40000*	40000*	39800	38200
60	40800	-18	41000	41000	41000	41000	39900
55	41000	-18	41000	41000	41000	41000	41000
50	41000	-18	41000	41000	41000	41000	41000
45	41000	-18	41000	41000	41000	41000	41000
40	41000	-18	41000	41000	41000	41000	41000

ISA + 15°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
85	33500	-6	34000*	34000*	34000*	34000*	32600
80	34800	-9	35500*	35500*	35500*	35500	33900
75	36200	-12	36700*	36700*	36700*	36700*	35200
70	37600	-12	37900*	37900*	37900*	37900*	36700
65	39100	-12	39200*	39200*	39200*	39200*	38200
60	40800	-12	40400*	40400*	40400*	40400*	39900
55	41000	-12	41000	41000	41000	41000	41000
50	41000	-12	41000	41000	41000	41000	41000
45	41000	-12	41000	41000	41000	41000	41000
40	41000	-12	41000	41000	41000	41000	41000

ISA + 20°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
85	33500	-1	32400*	32400*	32400*	32400*	32400*
80	34800	-4	34300*	34300*	34300*	34300*	33900
75	36200	-7	35800*	35800*	35800*	35800*	35200
70	37600	-7	37000*	37000*	37000*	37000*	36700
65	39100	-7	38200*	38200*	38200*	38200*	38200
60	40800	-7	39500*	39500*	39500*	39500*	39500*
55	41000	-7	40900*	40900*	40900*	40900*	40900*
50	41000	-7	41000	41000	41000	41000	41000
45	41000	-7	41000	41000	41000	41000	41000
40	41000	-7	41000	41000	41000	41000	41000

***Denotes altitude thrust limited in level flight, 100 fpm residual rate of climb.**

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)								
		25	27	29	31	33	35	37	39	41
85	%N1	80.4	81.8	83.4	84.7	86.2	88.1			
	MACH	.737	.762	.787	.796	.797	.789			
	KIAS	309	307	305	296	283	268			
	FF/ENG	1312	1305	1303	1289	1276	1278			
80	%N1	79.1	80.6	82.0	83.5	84.9	86.4			
	MACH	.719	.744	.770	.792	.797	.795			
	KIAS	301	300	298	294	283	270			
	FF/ENG	1239	1234	1228	1225	1210	1200			
75	%N1	77.7	79.2	80.6	82.1	83.5	85.0	87.0		
	MACH	.700	.726	.751	.778	.794	.797	.793		
	KIAS	292	292	290	289	282	271	257		
	FF/ENG	1165	1161	1155	1153	1146	1134	1134		
70	%N1	76.0	77.7	79.1	80.6	82.1	83.4	85.3	88.2	
	MACH	.679	.706	.732	.758	.784	.796	.797	.789	
	KIAS	283	283	282	280	278	270	259	244	
	FF/ENG	1089	1088	1083	1077	1079	1068	1063	1078	
65	%N1	74.2	75.9	77.5	79.0	80.4	82.0	83.7	86.0	
	MACH	.656	.683	.710	.737	.763	.788	.796	.796	
	KIAS	273	273	273	272	270	268	258	247	
	FF/ENG	1013	1012	1010	1006	1002	1004	997	1001	
60	%N1	72.3	74.0	75.7	77.3	78.8	80.2	82.1	84.2	86.6
	MACH	.633	.658	.686	.714	.740	.767	.791	.797	.795
	KIAS	263	263	263	262	261	260	256	247	235
	FF/ENG	939	935	935	933	930	928	935	933	936
55	%N1	70.3	71.9	73.6	75.3	76.9	78.4	80.2	82.5	84.6
	MACH	.612	.633	.659	.687	.715	.742	.770	.792	.797
	KIAS	254	252	252	252	252	250	249	245	236
	FF/ENG	872	861	858	859	858	861	864	870	868
50	%N1	68.2	69.8	71.3	73.1	74.8	76.4	78.2	80.4	82.7
	MACH	.589	.610	.632	.658	.686	.715	.742	.770	.792
	KIAS	244	242	241	240	241	240	239	238	234
	FF/ENG	804	796	783	785	783	794	797	808	803
45	%N1	65.5	67.4	69.0	70.6	72.3	74.0	76.0	78.2	80.4
	MACH	.558	.584	.607	.628	.654	.683	.712	.740	.767
	KIAS	230	231	231	229	229	229	228	227	226
	FF/ENG	727	734	722	717	715	725	731	739	747
40	%N1	62.6	64.3	66.2	68.0	69.6	71.2	73.4	75.8	77.9
	MACH	.527	.550	.576	.600	.622	.647	.676	.706	.734
	KIAS	217	217	218	218	217	216	216	216	215
	FF/ENG	669	661	665	657	659	654	663	670	679

Shaded area approximates optimum altitude.

Long Range Cruise Enroute Fuel and Time - Low Altitudes

Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
295	270	248	230	214	200	190	181	173	166	159
444	406	373	345	321	300	286	272	260	249	239
594	543	498	461	429	400	381	363	347	332	319
744	680	623	576	536	500	476	454	434	415	398
894	817	749	692	643	600	571	544	520	498	478
1044	953	874	807	750	700	666	635	607	581	558
1195	1091	999	923	858	800	761	726	693	664	638
1346	1228	1125	1039	965	900	857	817	780	747	718
1498	1366	1251	1155	1073	1000	952	908	867	830	797
1650	1504	1377	1270	1180	1100	1047	998	954	913	876
1802	1643	1503	1386	1288	1200	1142	1089	1040	995	955
1955	1781	1629	1503	1395	1300	1238	1180	1127	1078	1035
2108	1920	1756	1619	1503	1400	1333	1270	1213	1161	1114
2261	2059	1882	1735	1611	1500	1427	1360	1299	1243	1193
2415	2199	2009	1852	1718	1600	1522	1451	1385	1325	1272
2569	2338	2136	1968	1826	1700	1617	1541	1472	1408	1351
2724	2478	2263	2085	1934	1800	1713	1632	1558	1491	1430
2879	2619	2391	2202	2042	1900	1807	1722	1644	1573	1509
3035	2760	2519	2319	2150	2000	1902	1812	1730	1655	1588

Table 2 of 3: Reference Fuel And Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		20		24		28	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	1.2	0:42	1.1	0:40	0.9	0:38	0.8	0:37	0.7	0:35
300	1.9	1:02	1.7	0:59	1.5	0:55	1.3	0:53	1.2	0:50
400	2.5	1:22	2.3	1:18	2.0	1:12	1.8	1:09	1.6	1:06
500	3.2	1:42	2.9	1:37	2.6	1:29	2.3	1:25	2.1	1:21
600	3.8	2:02	3.5	1:56	3.1	1:46	2.8	1:41	2.6	1:36
700	4.4	2:22	4.1	2:15	3.7	2:04	3.3	1:57	3.0	1:51
800	5.1	2:42	4.7	2:34	4.2	2:21	3.8	2:13	3.5	2:07
900	5.7	3:02	5.3	2:53	4.7	2:38	4.3	2:30	3.9	2:22
1000	6.3	3:23	5.9	3:12	5.3	2:56	4.8	2:46	4.4	2:38
1100	7.0	3:43	6.5	3:32	5.8	3:14	5.2	3:03	4.8	2:53
1200	7.6	4:04	7.1	3:51	6.3	3:31	5.7	3:19	5.3	3:09
1300	8.2	4:25	7.7	4:11	6.9	3:49	6.2	3:36	5.7	3:25
1400	8.9	4:45	8.2	4:31	7.4	4:07	6.7	3:52	6.2	3:40
1500	9.5	5:06	8.8	4:50	7.9	4:25	7.2	4:09	6.6	3:56
1600	10.1	5:27	9.4	5:10	8.5	4:43	7.6	4:26	7.1	4:12
1700	10.7	5:49	10.0	5:30	9.0	5:01	8.1	4:43	7.5	4:28
1800	11.3	6:10	10.6	5:50	9.5	5:20	8.6	5:00	8.0	4:44
1900	11.9	6:31	11.1	6:11	10.0	5:38	9.1	5:17	8.4	5:00
2000	12.6	6:53	11.7	6:31	10.5	5:57	9.5	5:34	8.8	5:16

Long Range Cruise Enroute Fuel and Time - Low Altitudes
Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	40	50	60	70	80
1	-0.1	0.0	0.0	0.0	0.1
2	-0.2	-0.1	0.0	0.1	0.3
3	-0.3	-0.2	0.0	0.2	0.4
4	-0.4	-0.2	0.0	0.3	0.6
5	-0.5	-0.3	0.0	0.4	0.8
6	-0.7	-0.3	0.0	0.5	0.9
7	-0.8	-0.4	0.0	0.6	1.1
8	-0.9	-0.4	0.0	0.7	1.3
9	-1.0	-0.5	0.0	0.7	1.5
10	-1.1	-0.6	0.0	0.8	1.6
11	-1.3	-0.6	0.0	0.9	1.8
12	-1.4	-0.7	0.0	1.0	2.0
13	-1.5	-0.7	0.0	1.1	2.2

Long Range Cruise Enroute Fuel and Time - High Altitudes
Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
538	504	473	446	422	400	382	366	351	337	325
804	754	708	668	633	600	574	549	527	507	489
1071	1005	944	891	843	800	765	733	704	677	653
1339	1256	1180	1113	1054	1000	957	917	880	846	816
1607	1507	1416	1336	1265	1200	1149	1101	1057	1016	979
1876	1759	1652	1559	1476	1400	1340	1284	1233	1186	1142
2146	2011	1889	1782	1687	1600	1531	1468	1409	1355	1305
2417	2264	2126	2005	1898	1800	1723	1651	1584	1524	1468
2688	2518	2364	2229	2109	2000	1914	1834	1760	1692	1631
2960	2772	2602	2453	2321	2200	2105	2017	1935	1861	1794
3233	3027	2840	2677	2532	2400	2296	2200	2111	2030	1956
3507	3282	3079	2901	2744	2600	2487	2383	2287	2198	2118
3780	3537	3318	3126	2955	2800	2679	2566	2462	2366	2279
4055	3793	3557	3350	3167	3000	2870	2749	2637	2535	2441
4331	4050	3796	3575	3379	3200	3061	2931	2812	2702	2603
4607	4307	4036	3800	3590	3400	3252	3114	2987	2870	2764
4883	4564	4277	4025	3802	3600	3442	3296	3161	3038	2925
5161	4823	4517	4251	4015	3800	3633	3479	3336	3205	3086
5439	5081	4758	4477	4227	4000	3824	3661	3510	3372	3247
5718	5340	4999	4702	4439	4200	4015	3843	3684	3539	3408
5998	5600	5241	4928	4651	4400	4205	4025	3859	3706	3568
6279	5860	5483	5154	4864	4600	4396	4207	4033	3873	3728
6561	6121	5725	5381	5076	4800	4587	4389	4207	4040	3888
6844	6383	5968	5608	5289	5000	4778	4571	4381	4206	4048
7128	6646	6212	5835	5502	5200	4968	4753	4554	4372	4207
7414	6909	6456	6062	5715	5400	5158	4934	4727	4538	4367
7701	7174	6701	6290	5928	5600	5348	5115	4900	4704	4525
7989	7440	6946	6518	6141	5800	5539	5296	5073	4869	4684
8278	7706	7192	6747	6355	6000	5729	5477	5246	5034	4842

Long Range Cruise Enroute Fuel and Time - High Altitudes

Table 2 of 3: Reference Fuel And Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	29		31		33		35		37	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
400	1.6	1:05	1.6	1:03	1.5	1:02	1.4	1:01	1.4	1:00
600	2.5	1:35	2.4	1:32	2.3	1:30	2.3	1:28	2.2	1:27
800	3.4	2:05	3.3	2:02	3.2	1:59	3.1	1:56	3.0	1:53
1000	4.3	2:35	4.2	2:31	4.0	2:27	3.9	2:24	3.8	2:20
1200	5.2	3:06	5.0	3:01	4.9	2:56	4.7	2:52	4.6	2:47
1400	6.1	3:37	5.9	3:30	5.7	3:25	5.5	3:20	5.4	3:14
1600	6.9	4:08	6.7	4:00	6.5	3:54	6.3	3:48	6.2	3:41
1800	7.8	4:39	7.6	4:31	7.3	4:23	7.1	4:16	6.9	4:09
2000	8.7	5:11	8.4	5:01	8.1	4:52	7.9	4:44	7.7	4:36
2200	9.5	5:43	9.2	5:32	8.9	5:22	8.7	5:13	8.5	5:04
2400	10.4	6:15	10.0	6:03	9.7	5:52	9.5	5:42	9.2	5:32
2600	11.2	6:47	10.9	6:34	10.5	6:22	10.3	6:11	10.0	6:00
2800	12.0	7:19	11.7	7:05	11.3	6:52	11.0	6:40	10.7	6:28
3000	12.9	7:52	12.5	7:37	12.1	7:22	11.8	7:09	11.5	6:56
3200	13.7	8:25	13.3	8:09	12.8	7:53	12.6	7:39	12.2	7:25
3400	14.5	8:58	14.0	8:41	13.6	8:24	13.3	8:09	13.0	7:54
3600	15.3	9:31	14.8	9:13	14.4	8:55	14.1	8:39	13.7	8:23
3800	16.1	10:05	15.6	9:46	15.1	9:27	14.8	9:09	14.4	8:52
4000	16.9	10:39	16.4	10:18	15.9	9:58	15.5	9:40	15.1	9:21
4200	17.7	11:13	17.2	10:51	16.6	10:30	16.3	10:10	15.9	9:50
4400	18.5	11:47	17.9	11:25	17.4	11:02	17.0	10:41	16.6	10:20
4600	19.3	12:22	18.7	11:58	18.1	11:34	17.7	11:12	17.3	10:50
4800	20.0	12:57	19.4	12:32	18.9	12:07	18.4	11:44	18.0	11:20
5000	20.8	13:32	20.2	13:06	19.6	12:40	19.2	12:15	18.7	11:50
5200	21.6	14:08	20.9	13:40	20.3	13:13	19.9	12:48	19.4	12:21
5400	22.4	14:44	21.7	14:14	21.1	13:46	20.6	13:20	20.1	12:51
5600	23.1	15:20	22.4	14:49	21.8	14:20	21.3	13:52	20.8	13:22
5800	23.9	15:57	23.1	15:24	22.5	14:54	22.0	14:25	21.4	13:54
6000	24.7	16:34	23.9	16:00	23.2	15:28	22.7	14:58	22.1	14:25

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	40	50	60	70	80
2	-0.2	-0.1	0.0	0.2	0.5
4	-0.5	-0.3	0.0	0.4	1.0
6	-0.8	-0.5	0.0	0.6	1.5
8	-1.1	-0.6	0.0	0.8	2.0
10	-1.4	-0.7	0.0	1.0	2.4
12	-1.7	-0.9	0.0	1.2	2.8
14	-2.0	-1.0	0.0	1.4	3.2
16	-2.3	-1.2	0.0	1.5	3.6
18	-2.6	-1.3	0.0	1.7	3.9
20	-2.9	-1.4	0.0	1.8	4.2
22	-3.3	-1.6	0.0	2.0	4.5
24	-3.6	-1.7	0.0	2.1	4.7
26	-4.0	-1.9	0.0	2.2	4.9

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 KG)									
	85	80	75	70	65	60	55	50	45	40
41					13	1	0	3	14	30
39			25	8	0	0	3	13	27	44
37		16	4	0	0	4	13	26	41	59
35	9	1	0	0	5	14	26	40	56	72
33	0	0	1	7	16	27	40	54	69	85
31	0	3	10	18	29	40	53	67	82	97
29	6	13	21	31	42	54	67	80	93	107
27	16	25	34	44	55	67	79	91	104	116
25	29	38	47	58	68	79	91	102	113	124
23	41	51	60	70	80	90	101	111	121	131

The above wind factor table is for calculation of wind required to maintain present range capability at new pressure altitude, i.e., break-even wind.

Method:

1. **Read wind factors for present and new altitudes from table.**
2. **Determine difference (new altitude wind factor minus present altitude wind factor); this difference may be negative or positive.**
3. **Break-even wind at new altitude is present altitude wind plus difference from step 2.**

Descent at .78/280/250 KIAS

PRESSURE ALTITUDE (FT)	TIME (MIN)	FUEL (KG)	DISTANCE (NM)			
			LANDING WEIGHT (1000 KG)			
			40	50	60	70
41000	26	270	102	119	132	141
39000	25	260	96	113	126	135
37000	24	250	91	107	119	128
35000	24	250	87	102	114	123
33000	23	240	83	97	108	117
31000	22	240	78	91	102	110
29000	21	230	73	86	95	103
27000	20	230	69	80	89	96
25000	19	220	64	74	83	89
23000	18	210	59	69	76	82
21000	17	200	55	63	70	75
19000	16	190	51	58	64	69
17000	15	190	46	53	58	62
15000	14	180	42	48	53	56
10000	10	140	30	33	36	37
5000	7	110	18	19	20	21
1500	4	80	10	10	10	10

Allowances for a straight-in approach are included.

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT) 1500	5000	10000	15000	20000	25000	30000	35000	41000
85	%N1	57.8	60.4	64.2	68.4	73.2	78.1	82.6		
	KIAS	244	244	246	247	249	251	254		
	FF/ENG	1220	1200	1200	1190	1190	1200	1220		
80	%N1	56.2	58.8	62.6	66.8	71.5	76.4	81.0	85.9	
	KIAS	237	237	238	239	242	243	246	249	
	FF/ENG	1150	1140	1130	1130	1120	1120	1140	1190	
75	%N1	54.6	57.1	60.8	65.1	69.6	74.6	79.4	84.1	
	KIAS	229	229	230	232	233	235	238	241	
	FF/ENG	1090	1070	1070	1070	1070	1050	1060	1100	
70	%N1	53.0	55.3	59.0	63.2	67.7	72.7	77.6	82.2	
	KIAS	220	222	222	224	225	227	229	232	
	FF/ENG	1030	1010	1000	1010	1000	980	990	1010	
65	%N1	51.3	53.5	57.1	61.2	65.7	70.5	75.7	80.3	
	KIAS	211	214	214	215	216	218	220	223	
	FF/ENG	960	950	930	940	930	910	920	930	
60	%N1	49.5	51.7	55.1	59.1	63.6	68.3	73.5	78.3	86.0
	KIAS	204	204	206	206	208	209	211	213	217
	FF/ENG	900	890	870	870	870	840	840	860	930
55	%N1	47.6	49.8	53.1	56.9	61.3	65.9	71.0	76.1	83.7
	KIAS	198	198	198	198	199	200	201	203	207
	FF/ENG	850	840	810	800	800	780	780	790	850
50	%N1	45.7	47.8	51.0	54.5	58.8	63.4	68.3	73.6	81.1
	KIAS	191	191	191	191	191	191	192	193	196
	FF/ENG	790	780	760	740	730	730	720	730	770
45	%N1	43.8	45.8	48.9	52.2	56.2	60.8	65.4	70.6	78.4
	KIAS	185	185	185	185	185	185	185	185	185
	FF/ENG	740	720	700	680	670	660	660	660	690
40	%N1	41.8	43.7	46.7	49.9	53.5	57.9	62.5	67.5	75.4
	KIAS	178	178	178	178	178	178	178	178	178
	FF/ENG	690	670	640	620	610	600	590	590	620

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

ADVISORY INFORMATION

Runway Surface Condition Correlation

RUNWAY CONDITION CODE	RUNWAY SURFACE CONDITION DESCRIPTION	REPORTED BRAKING ACTION
6	Dry	Dry
5	Wet (Smooth, Grooved or PFC) or Frost 3 mm (0.12 inches) or less of: Water, Slush, Dry Snow or Wet Snow	Good
4	Compacted Snow at or below -15°C OAT	Good to Medium
3	Wet (Slippery), Dry Snow or Wet Snow (any depth) over Compacted Snow Greater than 3 mm (0.12 inches) of : Dry Snow or Wet Snow Compacted Snow at OAT warmer than -15°C	Medium
2	Greater than 3 mm (0.12 inches) of: Water or Slush	Medium to Poor
1	Ice	Poor
0	Wet Ice, Water on top of Compacted Snow, Dry Snow or Wet Snow over Ice	Nil

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF15	ONE REV	NO REV

Dry Runway

MAX MANUAL	1450	85/-85	35/50	-65/215	15/-15	35/-40	65	25	45
AUTOBRAKE MAX	1620	90/-95	40/55	-70/230	5/0	45/-45	85	5	10
AUTOBRAKE 3	1850	105/-115	50/70	-85/280	0/0	55/-55	105	0	0
AUTOBRAKE 2	2185	130/-140	65/90	-105/345	0/0	65/-65	125	0	0
AUTOBRAKE 1	2750	180/-195	90/120	-140/460	10/-30	85/-85	145	25	25

Good Reported Braking Action

MAX MANUAL	1820	130/-125	65/95	-100/355	35/-35	60/-60	95	95	185
AUTOBRAKE MAX	1840	130/-130	65/95	-100/350	35/-30	60/-60	100	95	190
AUTOBRAKE 3	1920	125/-125	60/95	-95/320	20/-15	55/-60	105	55	135
AUTOBRAKE 2	2215	135/-145	65/90	-105/355	10/-10	65/-70	130	0	0
AUTOBRAKE 1	2755	180/-195	90/120	-140/465	25/-35	85/-90	145	25	25

Good To Medium Reported Braking Action

MAX MANUAL	2005	135/-135	65/95	-105/375	55/-45	60/-60	95	125	265
AUTOBRAKE MAX	2020	135/-135	65/95	-105/370	50/-45	60/-60	100	130	270
AUTOBRAKE 3	2025	135/-135	65/95	-105/370	50/-35	60/-60	105	125	260
AUTOBRAKE 2	2235	135/-145	65/90	-110/375	25/-15	70/-70	130	25	90
AUTOBRAKE 1	2755	180/-195	90/120	-140/465	25/-35	85/-90	145	25	25

Medium Reported Braking Action

MAX MANUAL	2140	140/-140	70/100	-110/395	65/-55	65/-65	95	165	360
AUTOBRAKE MAX	2155	140/-140	70/100	-110/395	65/-55	65/-65	100	170	365
AUTOBRAKE 3	2155	140/-140	70/100	-110/395	65/-55	65/-65	100	170	365
AUTOBRAKE 2	2290	140/-150	70/95	-120/405	45/-25	70/-70	130	80	245
AUTOBRAKE 1	2760	180/-195	90/120	-140/470	35/-35	85/-90	145	35	65

ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 15

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF15	ONE REV	NO REV

Medium To Poor Reported Braking Action

MAX MANUAL	2455	190/-185	95/135	-145/520	100/-80	85/-85	115	300	735
AUTOBRAKE MAX	2470	195/-185	95/140	-145/525	110/-90	85/-85	115	300	745
AUTOBRAKE 3	2470	195/-185	95/140	-145/525	110/-90	85/-85	115	300	745
AUTOBRAKE 2	2470	195/-170	95/140	-140/525	110/-75	85/-85	115	300	745
AUTOBRAKE 1	2830	180/-195	90/130	-140/470	50/-55	85/-85	135	65	390

Poor Reported Braking Action

MAX MANUAL	3150	225/-225	115/155	-200/725	280/-180	100/-100	115	625	1770
AUTOBRAKE MAX	3165	230/-225	115/160	-200/725	290/-185	100/-100	115	630	1780
AUTOBRAKE 3	3165	230/-225	115/160	-200/725	290/-185	100/-100	115	630	1780
AUTOBRAKE 2	3165	230/-225	115/160	-200/725	290/-185	100/-100	115	630	1780
AUTOBRAKE 1	3280	230/-235	120/160	-200/740	265/-170	105/-105	135	525	1665

Reference distance is based on sea level, standard day, no wind or slope, VREF15, two-engine detent No. 2 reverse thrust, and auto or manual speedbrakes.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
All reference distances and adjustments shown have been increased by 15%.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF30	ONE REV	NO REV

Dry Runway

MAX MANUAL	1330	75/-80	35/45	-65/205	15/-15	35/-35	60	20	35
AUTOBRAKE MAX	1485	80/-90	40/50	-70/225	5/0	40/-40	80	5	10
AUTOBRAKE 3	1685	95/-105	50/60	-80/270	0/0	50/-50	100	0	0
AUTOBRAKE 2	1980	120/-130	60/75	-100/330	0/0	60/-60	120	0	0
AUTOBRAKE 1	2480	160/-170	80/105	-130/440	10/-30	75/-75	135	20	20

Good Reported Braking Action

MAX MANUAL	1625	115/-110	55/80	-95/330	30/-25	55/-55	90	65	125
AUTOBRAKE MAX	1655	115/-110	55/80	-90/325	30/-25	55/-55	95	70	135
AUTOBRAKE 3	1735	105/-110	55/80	-85/300	15/-10	50/-50	100	25	80
AUTOBRAKE 2	2005	120/-130	60/80	-100/335	10/-10	60/-60	125	0	0
AUTOBRAKE 1	2485	160/-170	80/105	-130/445	20/-30	80/-80	135	20	20

Good To Medium Reported Braking Action

MAX MANUAL	1805	115/-115	60/80	-100/355	45/-40	55/-55	90	95	200
AUTOBRAKE MAX	1835	120/-120	60/80	-100/350	45/-40	55/-55	95	100	205
AUTOBRAKE 3	1840	115/-120	60/80	-100/350	45/-30	55/-55	100	95	200
AUTOBRAKE 2	2025	120/-130	60/80	-105/355	20/-15	60/-60	125	20	70
AUTOBRAKE 1	2485	160/-170	80/105	-130/445	20/-30	80/-80	135	20	20

Medium Reported Braking Action

MAX MANUAL	1935	120/-125	60/85	-105/375	60/-50	55/-55	90	130	280
AUTOBRAKE MAX	1965	125/-125	60/85	-105/370	60/-50	55/-60	95	135	285
AUTOBRAKE 3	1960	125/-125	60/85	-105/375	60/-50	55/-60	95	135	285
AUTOBRAKE 2	2075	125/-135	65/85	-110/385	40/-25	65/-65	125	65	190
AUTOBRAKE 1	2485	165/-170	80/105	-130/450	30/-30	80/-80	135	30	50

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 30

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF30	ONE REV	NO REV

Medium To Poor Reported Braking Action

MAX MANUAL	2180	165/-165	85/115	-135/490	85/-70	75/-75	110	210	500
AUTOBRAKE MAX	2195	170/-165	85/120	-135/495	90/-75	75/-75	110	215	505
AUTOBRAKE 3	2195	170/-165	85/120	-135/495	90/-75	75/-75	110	215	505
AUTOBRAKE 2	2200	170/-150	85/120	-125/495	90/-55	75/-75	115	215	505
AUTOBRAKE 1	2540	160/-175	80/110	-135/445	45/-50	75/-80	125	40	175

Poor Reported Braking Action

MAX MANUAL	2850	200/-200	105/135	-190/700	260/-160	90/-90	110	505	1370
AUTOBRAKE MAX	2865	200/-200	105/140	-190/700	270/-170	90/-90	110	505	1380
AUTOBRAKE 3	2865	200/-200	105/140	-190/700	270/-170	90/-90	110	505	1380
AUTOBRAKE 2	2865	205/-200	105/140	-190/700	270/-165	90/-90	115	505	1380
AUTOBRAKE 1	2970	205/-205	105/140	-195/710	245/-155	95/-95	125	420	1280

Reference distance is based on sea level, standard day, no wind or slope, VREF30, two-engine detent No. 2 reverse thrust, and auto or manual speedbrakes.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
All reference distances and adjustments shown have been increased by 15%.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 40

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF40	ONE REV	NO REV

Dry Runway

MAX MANUAL	1280	90/-75	35/45	-60/205	15/-10	30/-35	65	20	30
AUTOBRAKE MAX	1420	95/-85	40/50	-65/220	5/0	35/-40	80	5	10
AUTOBRAKE 3	1605	115/-100	50/60	-80/265	0/0	45/-45	100	0	0
AUTOBRAKE 2	1880	140/-125	60/75	-95/320	0/0	55/-55	120	0	0
AUTOBRAKE 1	2360	185/-165	80/100	-130/430	5/-25	75/-75	130	10	10

Good Reported Braking Action

MAX MANUAL	1550	130/-105	55/75	-90/325	30/-25	50/-50	90	55	110
AUTOBRAKE MAX	1590	130/-110	60/80	-90/320	30/-25	50/-50	95	60	120
AUTOBRAKE 3	1655	125/-105	55/75	-85/295	15/-10	50/-50	100	25	70
AUTOBRAKE 2	1905	145/-125	60/75	-100/330	5/-5	55/-55	120	0	0
AUTOBRAKE 1	2365	185/-165	80/105	-130/435	15/-30	75/-75	135	10	10

Good To Medium Reported Braking Action

MAX MANUAL	1735	135/-110	60/80	-95/345	45/-40	50/-50	90	85	175
AUTOBRAKE MAX	1770	135/-115	60/80	-95/345	45/-40	55/-50	95	90	185
AUTOBRAKE 3	1765	135/-115	60/80	-95/345	45/-35	55/-55	100	90	185
AUTOBRAKE 2	1930	145/-130	60/80	-105/350	20/-15	60/-60	120	20	70
AUTOBRAKE 1	2365	185/-165	80/105	-130/435	15/-30	75/-75	135	10	10

Medium Reported Braking Action

MAX MANUAL	1865	135/-120	60/80	-105/365	60/-50	55/-55	90	120	250
AUTOBRAKE MAX	1895	140/-125	65/80	-105/365	60/-50	55/-55	95	125	260
AUTOBRAKE 3	1895	140/-125	65/85	-105/370	60/-50	55/-55	95	120	260
AUTOBRAKE 2	1985	150/-130	65/85	-110/380	40/-25	60/-60	120	65	185
AUTOBRAKE 1	2365	190/-165	80/105	-130/440	30/-30	75/-75	135	20	45

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 40

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF40	ONE REV	NO REV

Medium To Poor Reported Braking Action

MAX MANUAL	2075	185/-155	85/110	-135/480	80/-65	70/-70	105	185	420
AUTOBRAKE MAX	2095	185/-160	85/115	-135/485	90/-75	70/-70	110	185	430
AUTOBRAKE 3	2095	185/-160	85/115	-135/485	90/-75	70/-70	110	185	430
AUTOBRAKE 2	2095	190/-150	85/115	-130/485	90/-55	70/-70	115	185	430
AUTOBRAKE 1	2410	185/-170	80/105	-130/435	45/-45	75/-75	120	30	125

Poor Reported Braking Action

MAX MANUAL	2740	215/-195	100/130	-185/695	255/-160	85/-85	105	460	1220
AUTOBRAKE MAX	2760	220/-195	105/135	-185/695	265/-165	85/-85	110	460	1230
AUTOBRAKE 3	2760	220/-195	105/135	-185/695	265/-165	85/-85	110	460	1230
AUTOBRAKE 2	2760	225/-195	105/135	-185/695	265/-160	85/-85	115	460	1230
AUTOBRAKE 1	2850	225/-200	105/135	-190/705	245/-155	90/-90	120	385	1150

Reference distance is based on sea level, standard day, no wind or slope, VREF40, two-engine detent No. 2 reverse thrust, and auto or manual speedbrakes.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
All reference distances and adjustments shown have been increased by 15%.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Airspeed Unreliable (Flaps 15)

VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1370	85/-80	35/50	-60/190	15/-15	35/-35	N/A	30	50
AUTOBRAKE MAX	1555	80/-90	40/55	-65/210	0/0	40/-45	N/A	5	10
AUTOBRAKE 2	2115	120/-130	60/85	-95/315	0/0	65/-65	N/A	0	0

Good Reported Braking Action

MAX MANUAL	1735	120/-115	60/90	-90/320	35/-30	60/-60	N/A	100	205
AUTOBRAKE MAX	1760	125/-115	65/90	-90/315	35/-30	60/-60	N/A	105	215
AUTOBRAKE 2	2150	125/-135	65/85	-100/320	10/-10	65/-65	N/A	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1890	125/-120	65/90	-95/340	50/-40	60/-60	N/A	130	275
AUTOBRAKE MAX	1920	125/-125	65/90	-95/335	50/-40	60/-60	N/A	135	285
AUTOBRAKE 2	2170	125/-135	65/90	-100/340	20/-15	65/-65	N/A	20	75

Medium Reported Braking Action

MAX MANUAL	2005	130/-125	65/95	-100/355	60/-50	60/-60	N/A	165	365
AUTOBRAKE MAX	2030	130/-130	65/95	-100/355	60/-50	60/-60	N/A	170	375
AUTOBRAKE 3	2030	130/-130	65/95	-100/355	60/-45	60/-60	N/A	170	370

Medium To Poor Reported Braking Action

MAX MANUAL	2300	175/-165	90/125	-130/455	90/-75	80/-80	N/A	300	755
AUTOBRAKE MAX	2315	175/-165	90/130	-130/460	95/-80	80/-80	N/A	305	765
AUTOBRAKE 3	2315	175/-165	90/130	-130/460	95/-80	80/-80	N/A	305	765

Poor Reported Braking Action

MAX MANUAL	2885	205/-200	105/145	-175/635	240/-155	90/-90	N/A	585	1675
AUTOBRAKE MAX	2900	205/-200	110/145	-175/635	250/-160	90/-90	N/A	590	1685
AUTOBRAKE 3	2900	205/-200	110/145	-175/635	250/-160	90/-90	N/A	590	1685

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Airspeed Unreliable (Flaps 30)

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1260	75/-70	35/40	-55/185	15/-10	30/-35	N/A	20	35
AUTOBRAKE MAX	1430	75/-80	40/50	-60/205	0/0	40/-40	N/A	0	10
AUTOBRAKE 2	1925	110/-120	55/75	-90/300	0/0	60/-60	N/A	0	0

Good Reported Braking Action

MAX MANUAL	1555	105/-100	55/75	-85/300	30/-25	50/-50	N/A	70	145
AUTOBRAKE MAX	1595	105/-105	55/75	-85/295	30/-25	50/-50	N/A	80	155
AUTOBRAKE 2	1955	110/-120	60/75	-95/305	5/-10	60/-60	N/A	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1710	110/-105	55/75	-90/320	45/-35	50/-50	N/A	100	205
AUTOBRAKE MAX	1750	110/-110	55/80	-90/315	45/-35	55/-55	N/A	105	215
AUTOBRAKE 2	1975	115/-120	60/80	-95/325	20/-15	60/-60	N/A	15	60

Medium Reported Braking Action

MAX MANUAL	1820	115/-110	60/80	-95/335	55/-45	55/-55	N/A	130	280
AUTOBRAKE MAX	1860	115/-115	60/80	-95/335	55/-45	55/-55	N/A	135	295
AUTOBRAKE 3	1855	115/-115	60/80	-95/335	55/-40	55/-55	N/A	135	290

Medium To Poor Reported Braking Action

MAX MANUAL	2055	150/-145	80/110	-120/435	75/-60	70/-70	N/A	220	520
AUTOBRAKE MAX	2070	155/-145	80/110	-120/435	85/-70	70/-70	N/A	220	530
AUTOBRAKE 3	2070	155/-145	80/110	-120/435	85/-70	70/-70	N/A	220	530

Poor Reported Braking Action

MAX MANUAL	2625	180/-180	95/125	-165/615	225/-140	80/-80	N/A	470	1295
AUTOBRAKE MAX	2640	180/-180	95/125	-165/615	230/-145	85/-85	N/A	475	1305
AUTOBRAKE 3	2640	180/-180	95/125	-165/615	230/-145	85/-85	N/A	475	1305

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Airspeed Unreliable (Flaps 40)

VREF40

BRAKING CONFIGURATION	REF DIST 65000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 65000 KG	ALT ADJ PER 1000 FT STD/HIGH*	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABOVE VREF	REVERSE THRUST ADJ ONE REV	REVERSE THRUST ADJ NO REV
Dry Runway									
MAX MANUAL	1215	85/-70	35/40	-55/180	15/-10	30/-30	N/A	20	35
AUTOBRAKE MAX	1370	90/-80	40/50	-60/200	5/0	35/-35	N/A	0	10
AUTOBRAKE 2	1835	135/-115	60/75	-90/295	0/0	55/-55	N/A	0	0
Good Reported Braking Action									
MAX MANUAL	1490	120/-100	55/75	-80/290	30/-25	50/-50	N/A	65	125
AUTOBRAKE MAX	1535	125/-100	55/75	-80/290	30/-25	50/-50	N/A	70	135
AUTOBRAKE 2	1865	135/-115	60/75	-90/300	5/-10	55/-55	N/A	0	0
Good To Medium Reported Braking Action									
MAX MANUAL	1645	125/-105	55/75	-90/310	40/-35	50/-50	N/A	90	185
AUTOBRAKE MAX	1690	130/-105	60/75	-90/310	40/-35	50/-50	N/A	95	195
AUTOBRAKE 2	1885	135/-120	60/75	-95/315	20/-15	55/-55	N/A	15	60
Medium Reported Braking Action									
MAX MANUAL	1755	130/-110	60/75	-95/330	55/-45	50/-50	N/A	120	255
AUTOBRAKE MAX	1800	135/-115	60/80	-95/330	55/-45	55/-55	N/A	125	265
AUTOBRAKE 3	1800	135/-115	60/80	-95/330	55/-45	55/-55	N/A	125	265
Medium To Poor Reported Braking Action									
MAX MANUAL	1965	170/-140	80/105	-120/425	75/-60	65/-65	N/A	190	445
AUTOBRAKE MAX	1980	170/-140	80/105	-120/425	80/-65	65/-70	N/A	195	450
AUTOBRAKE 3	1980	170/-140	80/105	-120/425	80/-65	65/-70	N/A	195	450
Poor Reported Braking Action									
MAX MANUAL	2530	200/-175	95/120	-165/610	220/-140	80/-80	N/A	430	1155
AUTOBRAKE MAX	2550	200/-175	95/125	-165/610	230/-145	80/-80	N/A	435	1165
AUTOBRAKE 3	2550	200/-175	95/125	-165/610	230/-145	80/-80	N/A	435	1165

LANDING DISTANCE AND ADJUSTMENTS (M)

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

All Flaps Up Landing

VREF40 + 55

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1720	180/-90	50/80	-65/205	20/-15	45/-45	60	45	75
AUTOBRAKE MAX	2060	125/-95	60/75	-75/235	5/0	55/-55	85	5	15
AUTOBRAKE 2	2885	155/-150	90/115	-110/360	0/0	90/-90	135	0	0

Good Reported Braking Action

MAX MANUAL	2315	160/-140	90/120	-105/365	50/-45	80/-80	90	185	390
AUTOBRAKE MAX	2340	160/-140	90/120	-105/365	50/-40	80/-80	95	195	400
AUTOBRAKE 2	2930	160/-155	95/115	-115/370	10/-10	90/-90	135	0	0

Good To Medium Reported Braking Action

MAX MANUAL	2470	165/-145	90/125	-110/385	60/-55	80/-80	90	220	465
AUTOBRAKE MAX	2500	165/-145	95/125	-110/385	60/-55	80/-80	95	225	475
AUTOBRAKE 2	2950	160/-155	95/115	-115/385	20/-15	90/-90	135	20	80

Medium Reported Braking Action

MAX MANUAL	2585	170/-150	95/125	-115/405	75/-65	85/-85	90	255	565
AUTOBRAKE MAX	2615	170/-150	95/125	-115/400	75/-60	85/-85	95	265	575
AUTOBRAKE 3	2660	160/-140	90/125	-115/385	60/-45	80/-80	105	220	535

Medium To Poor Reported Braking Action

MAX MANUAL	3070	230/-200	125/170	-150/515	120/-100	105/-105	105	525	1410
AUTOBRAKE MAX	3080	230/-205	130/170	-150/515	125/-105	105/-105	105	525	1415
AUTOBRAKE 3	3080	230/-200	130/170	-150/515	125/-105	105/-105	105	525	1415

Poor Reported Braking Action

MAX MANUAL	3680	260/-240	145/190	-190/685	280/-185	115/-115	105	855	2535
AUTOBRAKE MAX	3695	260/-240	145/190	-190/690	285/-190	115/-120	105	860	2545
AUTOBRAKE 3	3695	260/-240	145/190	-190/690	285/-190	115/-120	105	860	2545

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ANTISKID INOPERATIVE (Flaps 15)

VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1930	120/-125	60/80	-100/340	60/-50	55/-55	80	150	340
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2245	175/-165	85/120	-130/480	95/-75	75/-75	100	295	745
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2605	190/-180	95/130	-160/585	190/-125	80/-80	100	455	1255
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2765	200/-195	100/140	-175/640	245/-155	85/-85	100	555	1625
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	2880	225/-215	115/160	-190/705	260/-165	95/-95	110	635	1925
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3485	270/-260	140/185	-260/1045	1345/-310	115/-115	110	1275	**
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

****Deceleration insufficient to stop airplane on the runway.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ANTISKID INOPERATIVE (Flaps 30)

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1750	105/-110	55/70	-95/330	55/-45	50/-50	75	120	265
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2005	150/-140	75/105	-125/455	80/-65	65/-65	95	215	530
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2355	165/-160	85/110	-150/560	170/-115	75/-70	95	360	965
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2505	175/-175	90/120	-165/620	230/-140	75/-75	95	450	1255
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	2590	200/-190	100/135	-180/675	240/-150	85/-85	105	495	1410
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3175	240/-230	125/160	-250/1015	1325/-285	105/-100	105	1065	**
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

****Deceleration insufficient to stop airplane on the runway.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ANTISKID INOPERATIVE (Flaps 40)

VREF40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1685	125/-105	55/70	-95/325	55/-45	45/-50	75	110	235
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	1910	170/-135	75/100	-120/445	80/-65	60/-60	95	190	460
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2265	185/-155	85/110	-150/550	170/-115	70/-70	95	330	860
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2410	195/-170	90/115	-165/615	225/-135	75/-75	95	405	1115
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	2475	215/-180	100/130	-175/665	235/-145	80/-80	100	440	1225
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3060	255/-225	120/155	-245/1015	1390/-285	100/-100	100	985	4565
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Jammed or Restricted Flight Controls (Flaps 15)

VREF15 + 10

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1370	85/-80	35/50	-60/190	15/-15	35/-35	55	30	50
AUTOBRAKE MAX	1555	80/-90	40/55	-65/210	0/0	40/-45	75	5	10
AUTOBRAKE 2	2115	120/-130	60/85	-95/315	0/0	65/-65	115	0	0

Good Reported Braking Action

MAX MANUAL	1735	120/-115	60/90	-90/320	35/-30	60/-60	85	100	205
AUTOBRAKE MAX	1760	125/-115	65/90	-90/315	35/-30	60/-60	90	105	215
AUTOBRAKE 2	2150	125/-135	65/85	-100/320	10/-10	65/-65	120	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1890	125/-120	65/90	-95/340	50/-40	60/-60	85	130	275
AUTOBRAKE MAX	1920	125/-125	65/90	-95/335	50/-40	60/-60	90	135	285
AUTOBRAKE 2	2170	125/-135	65/90	-100/340	20/-15	65/-65	120	20	75

Medium Reported Braking Action

MAX MANUAL	2005	130/-125	65/95	-100/355	60/-50	60/-60	85	165	365
AUTOBRAKE MAX	2030	130/-130	65/95	-100/355	60/-50	60/-60	90	170	375
AUTOBRAKE 3	2030	130/-130	65/95	-100/355	60/-45	60/-60	95	170	370

Medium To Poor Reported Braking Action

MAX MANUAL	2300	175/-165	90/125	-130/455	90/-75	80/-80	100	300	755
AUTOBRAKE MAX	2315	175/-165	90/130	-130/460	95/-80	80/-80	100	305	765
AUTOBRAKE 3	2315	175/-165	90/130	-130/460	95/-80	80/-80	100	305	765

Poor Reported Braking Action

MAX MANUAL	2885	205/-200	105/145	-175/635	240/-155	90/-90	100	585	1675
AUTOBRAKE MAX	2900	205/-200	110/145	-175/635	250/-160	90/-90	100	590	1685
AUTOBRAKE 3	2900	205/-200	110/145	-175/635	250/-160	90/-90	100	590	1685

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

LEADING EDGE FLAPS TRANSIT (Flaps 15)

VREF15 + 15

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1445	90/-80	40/50	-60/195	15/-15	40/-40	60	35	55
AUTOBRAKE MAX	1630	85/-90	45/55	-65/215	5/0	45/-45	80	5	10
AUTOBRAKE 2	2230	125/-135	65/90	-100/320	0/0	65/-70	120	0	0
Good Reported Braking Action									
MAX MANUAL	1855	130/-125	65/95	-95/330	40/-35	60/-60	90	120	245
AUTOBRAKE MAX	1885	130/-125	70/95	-95/325	40/-35	65/-60	95	125	260
AUTOBRAKE 2	2275	125/-135	70/90	-100/330	10/-10	70/-70	120	0	5
Good To Medium Reported Braking Action									
MAX MANUAL	2010	130/-130	70/100	-100/350	55/-45	65/-65	90	150	320
AUTOBRAKE MAX	2045	135/-130	70/100	-100/345	55/-45	65/-65	95	160	330
AUTOBRAKE 2	2295	130/-140	70/95	-105/350	25/-15	70/-70	120	20	95
Medium Reported Braking Action									
MAX MANUAL	2125	135/-135	70/100	-105/370	65/-55	65/-65	90	190	415
AUTOBRAKE MAX	2160	135/-135	70/100	-105/365	65/-55	65/-65	95	195	425
AUTOBRAKE 3	2160	135/-135	70/100	-105/365	65/-50	65/-65	95	190	425
Medium To Poor Reported Braking Action									
MAX MANUAL	2440	185/-175	95/135	-135/470	95/-80	85/-85	100	340	875
AUTOBRAKE MAX	2465	185/-175	95/135	-135/470	105/-85	85/-85	100	345	890
AUTOBRAKE 3	2465	185/-175	95/135	-135/470	105/-85	85/-85	100	345	890
Poor Reported Braking Action									
MAX MANUAL	3035	210/-210	115/150	-180/650	255/-160	95/-95	100	640	1840
AUTOBRAKE MAX	3055	215/-210	115/155	-180/650	260/-170	95/-95	100	645	1855
AUTOBRAKE 3	3055	215/-210	115/155	-180/650	260/-170	95/-95	100	645	1855

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF BOTH ENGINE DRIVEN GENERATORS (Flaps 15)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	2260	150/-155	75/105	-115/380	90/-75	65/-65	115	275	640
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2655	220/-200	110/160	-150/545	145/-110	90/-90	135	535	1540
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	3050	240/-225	120/170	-180/645	255/-170	100/-100	135	745	2285
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	3225	250/-240	130/180	-195/705	325/-200	105/-105	135	885	2915
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3360	285/-260	145/205	-210/775	350/-220	115/-115	145	1035	3755
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	4040	335/-315	175/235	-290/1135	1700/-385	135/-135	145	1865	**
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

****Deceleration insufficient to stop airplane on the runway.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

LOSS OF BOTH ENGINE DRIVEN GENERATORS (Flaps 30)

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	2075	135/-140	70/90	-110/370	85/-65	60/-60	110	225	515
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2395	195/-180	95/135	-140/515	130/-100	80/-80	130	410	1115
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2785	210/-200	110/145	-170/620	240/-160	90/-90	130	605	1765
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2955	225/-215	115/155	-190/685	310/-190	95/-95	130	725	2260
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3050	250/-230	130/180	-200/745	325/-200	105/-100	135	815	2685
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3715	300/-280	155/205	-280/1110	1720/-365	125/-120	135	1575	**
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

****Deceleration insufficient to stop airplane on the runway.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF BOTH ENGINE DRIVEN GENERATORS (Flaps 40)
VREF40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	2010	160/-135	70/90	-110/365	85/-70	60/-60	110	210	475
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2290	220/-170	95/130	-140/505	125/-95	75/-75	125	365	960
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2680	235/-195	105/140	-170/615	240/-155	85/-85	125	545	1555
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2845	250/-210	115/150	-185/680	310/-185	90/-90	125	660	1985
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	2920	275/-220	125/170	-200/735	320/-195	100/-100	130	725	2260
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3585	320/-270	155/200	-280/1105	1810/-360	120/-120	130	1440	**
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

****Deceleration insufficient to stop airplane on the runway.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

LOSS OF SYSTEM A (Flaps 15)

VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1410	90/-85	40/50	-60/200	20/-20	35/-40	75	30	50
AUTOBRAKE MAX	1440	85/-85	40/50	-65/205	10/-5	40/-40	75	25	40
AUTOBRAKE 2	1900	115/-125	55/75	-90/300	0/0	55/-55	110	0	0
Good Reported Braking Action									
MAX MANUAL	1855	145/-135	70/105	-100/350	55/-45	65/-65	115	160	300
AUTOBRAKE MAX	1810	145/-135	70/105	-100/350	60/-50	65/-65	115	150	275
AUTOBRAKE 2	2000	135/-135	65/100	-100/345	35/-25	65/-65	125	70	165
Good To Medium Reported Braking Action									
MAX MANUAL	2025	145/-140	70/105	-105/370	70/-60	65/-65	115	195	390
AUTOBRAKE MAX	1980	145/-135	70/105	-105/370	75/-65	65/-65	115	185	365
AUTOBRAKE 2	2030	135/-135	70/105	-105/360	55/-35	65/-65	125	140	320
Medium Reported Braking Action									
MAX MANUAL	2155	150/-145	75/105	-110/385	85/-70	65/-65	115	245	515
AUTOBRAKE MAX	2110	150/-140	75/110	-110/385	90/-75	65/-65	115	235	495
AUTOBRAKE 3	2110	150/-140	75/110	-110/385	90/-75	65/-65	115	235	495
Medium To Poor Reported Braking Action									
MAX MANUAL	2485	205/-190	105/150	-145/505	125/-100	85/-85	130	475	1235
AUTOBRAKE MAX	2470	205/-190	105/150	-140/505	135/-110	85/-85	130	470	1220
AUTOBRAKE 3	2470	205/-190	105/150	-140/505	135/-110	85/-85	130	470	1220
Poor Reported Braking Action									
MAX MANUAL	3130	240/-230	120/170	-190/680	310/-195	100/-100	130	845	2575
AUTOBRAKE MAX	3115	240/-230	120/170	-190/680	315/-200	100/-100	130	840	2560
AUTOBRAKE 3	3115	240/-230	120/170	-190/680	315/-200	100/-100	130	840	2560

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

LOSS OF SYSTEM A (Flaps 30)

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1275	80/-75	35/45	-60/190	15/-15	35/-35	70	25	35
AUTOBRAKE MAX	1310	80/-80	35/45	-60/195	10/-5	35/-35	75	20	30
AUTOBRAKE 2	1720	105/-110	50/65	-85/285	0/0	50/-50	105	0	0

Good Reported Braking Action

MAX MANUAL	1625	120/-115	60/85	-90/325	45/-35	55/-55	105	105	185
AUTOBRAKE MAX	1590	120/-115	60/85	-90/325	50/-40	55/-55	105	100	175
AUTOBRAKE 2	1785	115/-120	55/80	-95/315	25/-20	55/-55	115	35	75

Good To Medium Reported Braking Action

MAX MANUAL	1795	125/-120	60/85	-100/345	60/-50	55/-55	105	140	270
AUTOBRAKE MAX	1755	125/-115	60/90	-95/345	65/-55	55/-55	105	135	255
AUTOBRAKE 2	1810	120/-120	60/85	-100/335	40/-30	55/-55	115	95	220

Medium Reported Braking Action

MAX MANUAL	1920	130/-125	65/90	-100/360	75/-60	55/-55	100	180	375
AUTOBRAKE MAX	1885	130/-125	65/90	-100/360	80/-65	55/-55	105	175	360
AUTOBRAKE 3	1885	130/-125	65/90	-100/360	80/-65	55/-55	105	175	360

Medium To Poor Reported Braking Action

MAX MANUAL	2180	175/-165	90/125	-135/470	105/-85	75/-75	120	325	760
AUTOBRAKE MAX	2170	175/-165	90/125	-135/470	115/-90	75/-75	120	320	755
AUTOBRAKE 3	2170	175/-165	90/125	-135/470	115/-90	75/-75	120	320	755

Poor Reported Braking Action

MAX MANUAL	2805	205/-200	105/140	-180/655	280/-175	90/-90	120	650	1855
AUTOBRAKE MAX	2795	205/-200	105/145	-180/655	290/-180	90/-90	120	645	1850
AUTOBRAKE 3	2795	205/-200	105/145	-180/655	290/-180	90/-90	120	645	1850

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

LOSS OF SYSTEM A (Flaps 40)

VREF40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1225	95/-75	35/45	-60/190	15/-15	30/-35	70	20	30
AUTOBRAKE MAX	1255	95/-75	35/45	-60/195	10/-5	35/-35	75	20	30
AUTOBRAKE 2	1635	125/-110	50/65	-85/280	0/0	50/-50	105	0	0
Good Reported Braking Action									
MAX MANUAL	1540	140/-110	60/80	-90/315	40/-35	50/-50	100	90	155
AUTOBRAKE MAX	1515	145/-110	60/80	-90/315	45/-40	50/-50	105	85	145
AUTOBRAKE 2	1695	140/-115	60/80	-95/310	20/-20	55/-55	110	30	60
Good To Medium Reported Braking Action									
MAX MANUAL	1710	145/-115	60/85	-95/335	55/-45	55/-55	100	120	230
AUTOBRAKE MAX	1685	145/-110	65/85	-95/335	60/-50	55/-55	105	115	225
AUTOBRAKE 2	1725	140/-115	60/80	-95/330	45/-30	55/-55	110	90	200
Medium Reported Braking Action									
MAX MANUAL	1840	150/-120	65/85	-100/350	70/-60	55/-55	100	160	330
AUTOBRAKE MAX	1815	150/-120	65/85	-100/350	75/-65	55/-55	100	155	320
AUTOBRAKE 3	1815	150/-120	65/85	-100/350	75/-65	55/-55	100	155	320
Medium To Poor Reported Braking Action									
MAX MANUAL	2055	195/-155	85/115	-130/460	100/-80	70/-70	115	270	605
AUTOBRAKE MAX	2050	195/-160	85/120	-130/460	105/-85	70/-70	115	270	600
AUTOBRAKE 3	2050	195/-160	85/120	-130/460	105/-85	70/-70	115	270	600
Poor Reported Braking Action									
MAX MANUAL	2675	225/-190	105/135	-175/645	275/-170	85/-85	115	575	1580
AUTOBRAKE MAX	2675	230/-190	105/135	-175/645	280/-175	85/-85	115	575	1580
AUTOBRAKE 3	2675	230/-190	105/135	-175/645	280/-175	85/-85	115	575	1580

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF SYSTEM A AND SYSTEM B (Flaps 15)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1835	115/-110	50/70	-80/265	50/-40	50/-50	110	15	90
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2465	190/-175	95/140	-135/465	115/-95	85/-80	155	130	560
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2680	195/-185	100/140	-140/490	145/-115	90/-85	155	195	740
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2835	200/-190	100/145	-145/520	170/-130	90/-85	150	275	995
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3210	255/-240	130/190	-180/630	225/-170	110/-105	160	475	2160
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3950	300/-285	155/215	-240/880	565/-300	125/-120	160	1050	4815
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
LOSS OF SYSTEM B (Flaps 15)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1450	90/-90	40/55	-65/220	25/-20	40/-40	70	45	70
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	1830	140/-130	70/100	-100/360	50/-45	60/-60	100	150	290
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2020	145/-135	70/100	-110/390	70/-60	65/-65	100	195	405
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2155	150/-145	75/105	-115/415	90/-70	65/-65	95	245	545
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	2420	195/-185	95/140	-145/515	120/-95	85/-80	110	400	1000
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3075	230/-220	120/160	-200/745	365/-205	100/-100	110	805	2470
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
MANUAL REVERSION (Flaps 15)
VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1835	115/-110	50/70	-80/265	50/-40	50/-50	110	15	90
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good Reported Braking Action

MAX MANUAL	2465	190/-175	95/140	-135/465	115/-95	85/-80	155	130	560
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Good To Medium Reported Braking Action

MAX MANUAL	2680	195/-185	100/140	-140/490	145/-115	90/-85	155	195	740
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 2	Autobrake Inoperative								

Medium Reported Braking Action

MAX MANUAL	2835	200/-190	100/145	-145/520	170/-130	90/-85	150	275	995
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Medium To Poor Reported Braking Action

MAX MANUAL	3210	255/-240	130/190	-180/630	225/-170	110/-105	160	475	2160
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Poor Reported Braking Action

MAX MANUAL	3950	300/-285	155/215	-240/880	565/-300	125/-120	160	1050	4815
AUTOBRAKE MAX	Autobrake Inoperative								
AUTOBRAKE 3	Autobrake Inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

One Engine Inoperative Landing (Flaps 15)

VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1270	80/-75	35/45	-55/185	15/-15	35/-35	60	0	20
AUTOBRAKE MAX	1410	80/-85	35/50	-60/200	5/0	40/-40	75	0	5
AUTOBRAKE 2	1900	115/-125	55/75	-90/300	0/0	55/-55	110	0	0

Good Reported Braking Action

MAX MANUAL	1620	120/-115	60/85	-90/330	35/-30	55/-55	90	0	90
AUTOBRAKE MAX	1645	125/-115	60/85	-90/325	35/-30	55/-55	95	0	95
AUTOBRAKE 2	1920	120/-125	55/80	-95/305	10/-5	60/-60	115	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1800	125/-120	60/85	-95/345	55/-45	60/-55	90	0	130
AUTOBRAKE MAX	1820	125/-120	60/85	-95/340	50/-45	60/-55	95	0	135
AUTOBRAKE 2	1945	120/-130	60/80	-95/325	25/-15	60/-60	115	0	50

Medium Reported Braking Action

MAX MANUAL	1940	130/-125	65/90	-100/360	70/-55	60/-60	90	0	180
AUTOBRAKE MAX	1960	130/-130	65/90	-105/360	70/-55	60/-60	95	0	180
AUTOBRAKE 3	1955	130/-130	65/90	-105/360	70/-55	60/-60	95	0	180

Medium To Poor Reported Braking Action

MAX MANUAL	2290	190/-180	90/130	-145/515	110/-90	85/-85	115	0	380
AUTOBRAKE MAX	2300	190/-180	95/130	-145/515	120/-95	85/-85	115	0	385
AUTOBRAKE 3	2300	190/-180	95/130	-145/515	120/-95	85/-85	115	0	385

Poor Reported Braking Action

MAX MANUAL	3055	220/-220	110/145	-190/695	335/-200	100/-100	115	0	905
AUTOBRAKE MAX	3065	225/-220	110/150	-190/695	345/-210	100/-100	115	0	905
AUTOBRAKE 3	3065	225/-220	110/150	-190/695	345/-210	100/-100	115	0	905

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

One Engine Inoperative Landing (Flaps 30)

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1160	70/-70	30/40	-55/180	15/-10	30/-30	55	0	15
AUTOBRAKE MAX	1290	70/-75	35/45	-60/195	5/0	35/-35	70	0	5
AUTOBRAKE 2	1720	105/-110	50/65	-85/285	0/0	50/-50	105	0	0

Good Reported Braking Action

MAX MANUAL	1435	105/-100	50/70	-85/300	30/-25	50/-50	80	0	60
AUTOBRAKE MAX	1470	105/-100	50/70	-85/300	30/-25	50/-50	90	0	65
AUTOBRAKE 2	1735	105/-115	50/70	-90/290	5/-5	50/-55	110	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1610	110/-105	50/70	-90/320	45/-40	50/-50	80	0	95
AUTOBRAKE MAX	1640	110/-105	55/75	-90/315	45/-40	50/-50	90	0	100
AUTOBRAKE 2	1760	110/-115	55/70	-95/310	25/-15	55/-55	110	0	40

Medium Reported Braking Action

MAX MANUAL	1745	110/-115	55/75	-95/335	60/-50	50/-50	80	0	135
AUTOBRAKE MAX	1770	115/-115	55/75	-95/335	60/-50	55/-55	90	0	140
AUTOBRAKE 3	1770	115/-115	55/75	-95/335	60/-50	55/-55	90	0	140

Medium To Poor Reported Braking Action

MAX MANUAL	1995	160/-155	80/110	-130/475	90/-70	75/-75	105	0	250
AUTOBRAKE MAX	2005	165/-155	80/110	-130/475	100/-80	75/-75	105	0	255
AUTOBRAKE 3	2005	165/-155	80/110	-130/475	100/-80	75/-75	105	0	255

Poor Reported Braking Action

MAX MANUAL	2720	190/-195	95/125	-180/660	295/-180	85/-85	105	0	680
AUTOBRAKE MAX	2730	195/-195	95/130	-180/665	305/-185	90/-90	105	0	685
AUTOBRAKE 3	2730	195/-195	95/130	-180/665	305/-185	90/-90	105	0	685

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

SPOILERS (Flaps 15)

VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1480	90/-90	40/55	-65/205	25/-20	40/-40	90	55	90
AUTOBRAKE MAX	1455	90/-90	40/55	-65/205	15/-10	40/-40	85	50	85
AUTOBRAKE 2	1900	115/-125	55/75	-90/300	0/0	55/-55	110	0	0

Good Reported Braking Action

MAX MANUAL	1945	155/-145	75/115	-105/365	65/-55	65/-65	130	215	475
AUTOBRAKE MAX	1880	155/-140	75/115	-105/365	70/-60	65/-65	130	200	435
AUTOBRAKE 2	2035	150/-140	75/110	-105/355	50/-30	65/-65	130	140	350

Good To Medium Reported Braking Action

MAX MANUAL	2115	160/-150	80/115	-110/380	80/-65	70/-70	130	255	575
AUTOBRAKE MAX	2055	155/-145	80/115	-110/380	85/-70	70/-70	130	240	535
AUTOBRAKE 2	2070	155/-140	75/115	-110/375	85/-45	70/-70	130	230	525

Medium Reported Braking Action

MAX MANUAL	2250	165/-155	80/120	-115/400	100/-80	70/-70	130	310	730
AUTOBRAKE MAX	2190	160/-150	80/120	-115/395	105/-85	70/-70	130	295	690
AUTOBRAKE 3	2190	160/-150	80/120	-115/395	105/-85	70/-70	130	295	690

Medium To Poor Reported Braking Action

MAX MANUAL	2580	225/-205	110/165	-150/525	145/-115	90/-90	145	580	1805
AUTOBRAKE MAX	2555	225/-200	110/165	-150/520	155/-120	90/-90	145	565	1765
AUTOBRAKE 3	2555	225/-200	110/165	-150/520	155/-120	90/-90	145	565	1765

Poor Reported Braking Action

MAX MANUAL	3250	260/-245	135/185	-195/700	340/-215	105/-105	145	990	3390
AUTOBRAKE MAX	3220	255/-245	130/185	-195/695	350/-220	105/-105	145	980	3350
AUTOBRAKE 3	3220	255/-245	130/185	-195/695	350/-220	105/-105	145	980	3350

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

SPOILERS (Flaps 30)

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1380	85/-85	40/50	-65/205	25/-20	35/-35	90	50	75
AUTOBRAKE MAX	1345	80/-85	40/50	-60/200	15/-10	35/-35	85	45	70
AUTOBRAKE 2	1720	105/-110	50/65	-85/285	0/0	50/-50	105	0	0

Good Reported Braking Action

MAX MANUAL	1760	140/-130	70/100	-100/345	60/-50	60/-60	125	165	355
AUTOBRAKE MAX	1705	135/-125	70/100	-100/345	65/-50	60/-60	125	150	325
AUTOBRAKE 2	1840	135/-125	65/95	-100/340	45/-30	60/-60	125	105	255

Good To Medium Reported Braking Action

MAX MANUAL	1935	140/-135	70/100	-105/360	75/-60	60/-60	125	205	450
AUTOBRAKE MAX	1880	140/-130	70/100	-105/360	80/-65	60/-60	125	190	420
AUTOBRAKE 2	1880	140/-125	70/100	-105/360	80/-45	60/-60	125	190	420

Medium Reported Braking Action

MAX MANUAL	2070	145/-140	75/100	-110/380	90/-75	65/-60	125	260	595
AUTOBRAKE MAX	2010	145/-135	75/105	-105/380	95/-80	65/-60	125	245	565
AUTOBRAKE 3	2010	145/-135	75/105	-105/380	95/-80	65/-60	125	245	565

Medium To Poor Reported Braking Action

MAX MANUAL	2320	200/-180	100/140	-140/500	130/-100	80/-80	135	435	1250
AUTOBRAKE MAX	2295	200/-180	100/140	-140/495	140/-105	80/-80	135	425	1220
AUTOBRAKE 3	2295	200/-180	100/140	-140/495	140/-105	80/-80	135	425	1220

Poor Reported Braking Action

MAX MANUAL	2980	230/-220	120/160	-190/680	325/-200	95/-95	135	815	2630
AUTOBRAKE MAX	2955	230/-220	120/160	-190/680	330/-205	95/-95	135	805	2600
AUTOBRAKE 3	2955	230/-220	120/160	-190/680	330/-205	95/-95	135	805	2600

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

SPOILERS (Flaps 40)

VREF40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1355	105/-85	40/55	-65/205	25/-25	35/-35	100	50	75
AUTOBRAKE MAX	1305	100/-85	40/50	-60/200	15/-15	35/-35	90	45	70
AUTOBRAKE 2	1635	125/-110	50/65	-85/280	0/0	50/-50	105	0	0

Good Reported Braking Action

MAX MANUAL	1700	165/-125	70/95	-95/340	60/-50	55/-55	125	155	320
AUTOBRAKE MAX	1650	165/-125	70/95	-95/340	65/-55	55/-60	130	140	295
AUTOBRAKE 2	1770	165/-125	70/95	-100/340	50/-35	60/-60	130	105	240

Good To Medium Reported Braking Action

MAX MANUAL	1875	170/-130	70/95	-100/355	75/-60	60/-60	125	195	415
AUTOBRAKE MAX	1825	170/-130	70/100	-100/355	80/-65	60/-60	130	180	390
AUTOBRAKE 2	1825	170/-125	70/100	-100/355	80/-60	60/-60	130	180	390

Medium Reported Braking Action

MAX MANUAL	2010	175/-140	75/100	-110/375	95/-75	60/-60	125	245	555
AUTOBRAKE MAX	1960	175/-135	75/100	-105/370	100/-80	60/-60	125	230	525
AUTOBRAKE 3	1960	175/-135	75/100	-105/370	100/-80	60/-60	125	230	525

Medium To Poor Reported Braking Action

MAX MANUAL	2215	225/-175	100/135	-135/490	125/-95	80/-80	135	380	1035
AUTOBRAKE MAX	2195	225/-175	100/135	-135/485	135/-105	80/-80	135	370	1015
AUTOBRAKE 3	2195	225/-175	100/135	-135/485	135/-105	80/-80	135	370	1015

Poor Reported Braking Action

MAX MANUAL	2875	260/-215	120/155	-185/675	320/-195	90/-90	135	740	2295
AUTOBRAKE MAX	2850	260/-215	120/155	-185/675	330/-205	90/-95	135	735	2270
AUTOBRAKE 3	2850	260/-215	120/155	-185/675	330/-205	90/-95	135	735	2270

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Stabilizer Trim Inoperative (Flaps 15)

VREF15 + 10

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1370	85/-80	35/50	-60/190	15/-15	35/-35	55	30	50
AUTOBRAKE MAX	1555	80/-90	40/55	-65/210	0/0	40/-45	75	5	10
AUTOBRAKE 2	2115	120/-130	60/85	-95/315	0/0	65/-65	115	0	0

Good Reported Braking Action

MAX MANUAL	1735	120/-115	60/90	-90/320	35/-30	60/-60	85	100	205
AUTOBRAKE MAX	1760	125/-115	65/90	-90/315	35/-30	60/-60	90	105	215
AUTOBRAKE 2	2150	125/-135	65/85	-100/320	10/-10	65/-65	120	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1890	125/-120	65/90	-95/340	50/-40	60/-60	85	130	275
AUTOBRAKE MAX	1920	125/-125	65/90	-95/335	50/-40	60/-60	90	135	285
AUTOBRAKE 2	2170	125/-135	65/90	-100/340	20/-15	65/-65	120	20	75

Medium Reported Braking Action

MAX MANUAL	2005	130/-125	65/95	-100/355	60/-50	60/-60	85	165	365
AUTOBRAKE MAX	2030	130/-130	65/95	-100/355	60/-50	60/-60	90	170	375
AUTOBRAKE 3	2030	130/-130	65/95	-100/355	60/-45	60/-60	95	170	370

Medium To Poor Reported Braking Action

MAX MANUAL	2300	175/-165	90/125	-130/455	90/-75	80/-80	100	300	755
AUTOBRAKE MAX	2315	175/-165	90/130	-130/460	95/-80	80/-80	100	305	765
AUTOBRAKE 3	2315	175/-165	90/130	-130/460	95/-80	80/-80	100	305	765

Poor Reported Braking Action

MAX MANUAL	2885	205/-200	105/145	-175/635	240/-155	90/-90	100	585	1675
AUTOBRAKE MAX	2900	205/-200	110/145	-175/635	250/-160	90/-90	100	590	1685
AUTOBRAKE 3	2900	205/-200	110/145	-175/635	250/-160	90/-90	100	590	1685

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Trailing Edge Flap Asymmetry (1 ≤ Flap Lever < 15)

VREF40 + 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1435	115/-75	40/50	-60/195	15/-15	35/-40	55	30	55
AUTOBRAKE MAX	1660	100/-85	45/60	-65/215	0/0	45/-45	80	5	10
AUTOBRAKE 2	2275	140/-130	70/90	-100/325	0/0	70/-70	120	0	0
Good Reported Braking Action									
MAX MANUAL	1840	140/-115	70/95	-95/325	35/-30	60/-60	85	115	240
AUTOBRAKE MAX	1860	140/-115	70/95	-90/325	35/-30	60/-60	90	120	245
AUTOBRAKE 2	2300	140/-130	75/95	-100/330	10/-10	70/-70	120	0	0
Good To Medium Reported Braking Action									
MAX MANUAL	1995	140/-120	70/95	-100/345	50/-45	65/-65	85	150	310
AUTOBRAKE MAX	2015	140/-120	75/95	-100/345	50/-40	65/-65	90	150	320
AUTOBRAKE 2	2320	145/-130	75/95	-105/345	20/-15	70/-70	120	15	75
Medium Reported Braking Action									
MAX MANUAL	2110	145/-125	75/100	-105/365	60/-50	65/-65	85	185	405
AUTOBRAKE MAX	2125	145/-130	75/100	-105/360	60/-50	65/-65	90	185	410
AUTOBRAKE 3	2135	145/-125	75/100	-105/360	55/-40	65/-65	95	175	395
Medium To Poor Reported Braking Action									
MAX MANUAL	2450	195/-165	100/135	-130/465	95/-75	85/-85	100	350	905
AUTOBRAKE MAX	2450	195/-165	100/135	-130/465	100/-80	85/-85	100	350	905
AUTOBRAKE 3	2450	195/-165	100/135	-130/465	100/-80	85/-85	100	350	905
Poor Reported Braking Action									
MAX MANUAL	3035	225/-205	115/150	-175/640	245/-155	95/-95	100	645	1890
AUTOBRAKE MAX	3035	225/-205	120/155	-175/640	250/-165	95/-95	100	645	1890
AUTOBRAKE 3	3035	225/-205	120/155	-175/640	250/-165	95/-95	100	645	1890

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Trailing Edge Flap Asymmetry (Flap Lever 15 or 25)

VREF15

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1260	80/-75	35/45	-55/185	15/-10	30/-35	55	25	40
AUTOBRAKE MAX	1410	80/-85	35/50	-60/200	0/0	40/-40	75	5	10
AUTOBRAKE 2	1900	115/-125	55/75	-90/300	0/0	55/-55	110	0	0

Good Reported Braking Action

MAX MANUAL	1570	115/-110	55/80	-85/305	30/-30	50/-50	85	85	170
AUTOBRAKE MAX	1590	115/-110	55/80	-85/300	30/-25	50/-50	90	85	175
AUTOBRAKE 2	1925	120/-125	55/80	-95/310	10/-5	60/-60	115	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1730	120/-115	60/80	-90/325	45/-40	55/-55	85	115	240
AUTOBRAKE MAX	1745	120/-115	60/85	-90/320	45/-40	55/-55	90	115	245
AUTOBRAKE 2	1945	120/-130	60/80	-95/325	20/-15	60/-60	115	20	75

Medium Reported Braking Action

MAX MANUAL	1845	125/-120	60/85	-95/345	55/-45	55/-55	85	145	325
AUTOBRAKE MAX	1860	125/-125	60/85	-95/340	55/-45	55/-55	90	150	330
AUTOBRAKE 3	1860	125/-120	60/85	-95/340	55/-45	55/-55	90	150	330

Medium To Poor Reported Braking Action

MAX MANUAL	2105	165/-160	80/115	-125/445	85/-70	70/-70	100	260	660
AUTOBRAKE MAX	2120	170/-160	85/120	-125/445	90/-75	75/-75	100	265	670
AUTOBRAKE 3	2120	170/-160	85/120	-125/445	90/-75	75/-75	100	265	670

Poor Reported Braking Action

MAX MANUAL	2690	195/-190	100/135	-170/625	235/-150	85/-85	100	550	1580
AUTOBRAKE MAX	2705	200/-195	100/135	-170/625	245/-155	85/-85	100	550	1585
AUTOBRAKE 3	2705	200/-195	100/135	-170/625	245/-155	85/-85	100	550	1585

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Trailing Edge Flap Asymmetry (Flap Lever 30)
VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1150	70/-65	30/40	-55/180	10/-10	30/-30	55	20	30
AUTOBRAKE MAX	1290	70/-75	35/45	-60/195	0/0	35/-35	70	0	10
AUTOBRAKE 2	1720	105/-110	50/65	-85/285	0/0	50/-50	105	0	0

Good Reported Braking Action

MAX MANUAL	1405	100/-95	50/70	-80/285	25/-25	45/-45	75	60	115
AUTOBRAKE MAX	1435	100/-95	50/70	-80/280	25/-25	45/-45	85	60	125
AUTOBRAKE 2	1740	105/-115	50/70	-90/295	5/-5	50/-55	110	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1560	105/-100	50/70	-85/305	40/-35	45/-45	75	85	180
AUTOBRAKE MAX	1590	105/-100	50/70	-85/300	40/-35	45/-45	85	90	185
AUTOBRAKE 2	1760	110/-115	55/70	-90/310	20/-15	55/-55	110	15	60

Medium Reported Braking Action

MAX MANUAL	1670	105/-105	55/75	-90/325	50/-40	50/-50	75	115	250
AUTOBRAKE MAX	1695	110/-110	55/75	-90/320	50/-40	50/-50	85	120	260
AUTOBRAKE 3	1695	110/-110	55/75	-90/320	50/-45	50/-50	85	120	260

Medium To Poor Reported Braking Action

MAX MANUAL	1875	145/-140	70/100	-120/420	70/-60	65/-65	95	190	450
AUTOBRAKE MAX	1890	150/-140	75/100	-120/420	80/-65	65/-65	95	190	455
AUTOBRAKE 3	1890	150/-140	75/100	-120/420	80/-65	65/-65	95	190	455

Poor Reported Braking Action

MAX MANUAL	2440	175/-170	90/115	-160/600	220/-135	75/-75	95	440	1225
AUTOBRAKE MAX	2455	175/-170	90/120	-160/605	225/-140	75/-75	95	445	1230
AUTOBRAKE 3	2455	175/-170	90/120	-160/605	225/-140	75/-75	95	445	1230

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Trailing Edge Flap Disagree (1 ≤ Indicated Flaps < 15)

VREF40 + 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1435	115/-75	40/50	-60/195	15/-15	35/-40	55	30	55
AUTOBRAKE MAX	1660	100/-85	45/60	-65/215	0/0	45/-45	80	5	10
AUTOBRAKE 2	2275	140/-130	70/90	-100/325	0/0	70/-70	120	0	0

Good Reported Braking Action

MAX MANUAL	1840	140/-115	70/95	-95/325	35/-30	60/-60	85	115	240
AUTOBRAKE MAX	1860	140/-115	70/95	-90/325	35/-30	60/-60	90	120	245
AUTOBRAKE 2	2300	140/-130	75/95	-100/330	10/-10	70/-70	120	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1995	140/-120	70/95	-100/345	50/-45	65/-65	85	150	310
AUTOBRAKE MAX	2015	140/-120	75/95	-100/345	50/-40	65/-65	90	150	320
AUTOBRAKE 2	2320	145/-130	75/95	-105/345	20/-15	70/-70	120	15	75

Medium Reported Braking Action

MAX MANUAL	2110	145/-125	75/100	-105/365	60/-50	65/-65	85	185	405
AUTOBRAKE MAX	2125	145/-130	75/100	-105/360	60/-50	65/-65	90	185	410
AUTOBRAKE 3	2135	145/-125	75/100	-105/360	55/-40	65/-65	95	175	395

Medium To Poor Reported Braking Action

MAX MANUAL	2450	195/-165	100/135	-130/465	95/-75	85/-85	100	350	905
AUTOBRAKE MAX	2450	195/-165	100/135	-130/465	100/-80	85/-85	100	350	905
AUTOBRAKE 3	2450	195/-165	100/135	-130/465	100/-80	85/-85	100	350	905

Poor Reported Braking Action

MAX MANUAL	3035	225/-205	115/150	-175/640	245/-155	95/-95	100	645	1890
AUTOBRAKE MAX	3035	225/-205	120/155	-175/640	250/-165	95/-95	100	645	1890
AUTOBRAKE 3	3035	225/-205	120/155	-175/640	250/-165	95/-95	100	645	1890

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Trailing Edge Flap Disagree (15 ≤ Indicated Flaps < 30)

VREF15

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1260	80/-75	35/45	-55/185	15/-10	30/-35	55	25	40
AUTOBRAKE MAX	1410	80/-85	35/50	-60/200	0/0	40/-40	75	5	10
AUTOBRAKE 2	1900	115/-125	55/75	-90/300	0/0	55/-55	110	0	0

Good Reported Braking Action

MAX MANUAL	1570	115/-110	55/80	-85/305	30/-30	50/-50	85	85	170
AUTOBRAKE MAX	1590	115/-110	55/80	-85/300	30/-25	50/-50	90	85	175
AUTOBRAKE 2	1925	120/-125	55/80	-95/310	10/-5	60/-60	115	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1730	120/-115	60/80	-90/325	45/-40	55/-55	85	115	240
AUTOBRAKE MAX	1745	120/-115	60/85	-90/320	45/-40	55/-55	90	115	245
AUTOBRAKE 2	1945	120/-130	60/80	-95/325	20/-15	60/-60	115	20	75

Medium Reported Braking Action

MAX MANUAL	1845	125/-120	60/85	-95/345	55/-45	55/-55	85	145	325
AUTOBRAKE MAX	1860	125/-125	60/85	-95/340	55/-45	55/-55	90	150	330
AUTOBRAKE 3	1860	125/-120	60/85	-95/340	55/-45	55/-55	90	150	330

Medium To Poor Reported Braking Action

MAX MANUAL	2105	165/-160	80/115	-125/445	85/-70	70/-70	100	260	660
AUTOBRAKE MAX	2120	170/-160	85/120	-125/445	90/-75	75/-75	100	265	670
AUTOBRAKE 3	2120	170/-160	85/120	-125/445	90/-75	75/-75	100	265	670

Poor Reported Braking Action

MAX MANUAL	2690	195/-190	100/135	-170/625	235/-150	85/-85	100	550	1580
AUTOBRAKE MAX	2705	200/-195	100/135	-170/625	245/-155	85/-85	100	550	1585
AUTOBRAKE 3	2705	200/-195	100/135	-170/625	245/-155	85/-85	100	550	1585

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Trailing Edge Flap Disagree (30 ≤ Indicated Flaps < 40)

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1150	70/-65	30/40	-55/180	10/-10	30/-30	55	20	30
AUTOBRAKE MAX	1290	70/-75	35/45	-60/195	0/0	35/-35	70	0	10
AUTOBRAKE 2	1720	105/-110	50/65	-85/285	0/0	50/-50	105	0	0

Good Reported Braking Action

MAX MANUAL	1405	100/-95	50/70	-80/285	25/-25	45/-45	75	60	115
AUTOBRAKE MAX	1435	100/-95	50/70	-80/280	25/-25	45/-45	85	60	125
AUTOBRAKE 2	1740	105/-115	50/70	-90/295	5/-5	50/-55	110	0	0

Good To Medium Reported Braking Action

MAX MANUAL	1560	105/-100	50/70	-85/305	40/-35	45/-45	75	85	180
AUTOBRAKE MAX	1590	105/-100	50/70	-85/300	40/-35	45/-45	85	90	185
AUTOBRAKE 2	1760	110/-115	55/70	-90/310	20/-15	55/-55	110	15	60

Medium Reported Braking Action

MAX MANUAL	1670	105/-105	55/75	-90/325	50/-40	50/-50	75	115	250
AUTOBRAKE MAX	1695	110/-110	55/75	-90/320	50/-40	50/-50	85	120	260
AUTOBRAKE 3	1695	110/-110	55/75	-90/320	50/-45	50/-50	85	120	260

Medium To Poor Reported Braking Action

MAX MANUAL	1875	145/-140	70/100	-120/420	70/-60	65/-65	95	190	450
AUTOBRAKE MAX	1890	150/-140	75/100	-120/420	80/-65	65/-65	95	190	455
AUTOBRAKE 3	1890	150/-140	75/100	-120/420	80/-65	65/-65	95	190	455

Poor Reported Braking Action

MAX MANUAL	2440	175/-170	90/115	-160/600	220/-135	75/-75	95	440	1225
AUTOBRAKE MAX	2455	175/-170	90/120	-160/605	225/-140	75/-75	95	445	1230
AUTOBRAKE 3	2455	175/-170	90/120	-160/605	225/-140	75/-75	95	445	1230

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Trailing Edge Flaps Up Landing

VREF40 + 40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	65000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 65000 KG	PER 1000 FT STD/HIGH*	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10°C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV

Dry Runway

MAX MANUAL	1540	140/-80	45/55	-60/200	15/-15	40/-40	55	35	60
AUTOBRAKE MAX	1815	110/-90	50/65	-70/225	0/0	50/-50	80	5	10
AUTOBRAKE 2	2510	145/-135	80/100	-105/340	0/0	75/-75	125	0	0

Good Reported Braking Action

MAX MANUAL	2010	145/-125	75/105	-100/340	40/-35	70/-70	85	135	280
AUTOBRAKE MAX	2025	145/-125	75/105	-95/335	40/-35	70/-70	90	140	290
AUTOBRAKE 2	2530	150/-140	80/100	-105/345	10/-10	80/-80	125	0	0

Good To Medium Reported Braking Action

MAX MANUAL	2165	150/-130	80/105	-105/360	55/-45	70/-70	85	170	355
AUTOBRAKE MAX	2180	150/-130	80/105	-105/355	50/-45	70/-70	90	170	360
AUTOBRAKE 2	2550	150/-140	80/100	-110/360	20/-15	80/-80	125	15	70

Medium Reported Braking Action

MAX MANUAL	2275	155/-135	80/110	-110/375	65/-55	70/-70	85	205	445
AUTOBRAKE MAX	2290	155/-135	80/110	-110/375	65/-55	70/-70	90	205	455
AUTOBRAKE 3	2320	145/-130	80/110	-110/365	55/-40	70/-70	100	175	425

Medium To Poor Reported Braking Action

MAX MANUAL	2665	205/-180	110/145	-135/480	100/-85	90/-90	100	400	1040
AUTOBRAKE MAX	2660	205/-180	110/145	-135/480	105/-90	90/-90	100	400	1040
AUTOBRAKE 3	2660	205/-175	110/145	-135/480	105/-90	90/-90	100	400	1040

Poor Reported Braking Action

MAX MANUAL	3255	235/-215	125/165	-180/655	250/-165	105/-105	100	705	2060
AUTOBRAKE MAX	3250	235/-215	125/165	-180/655	260/-170	105/-105	100	705	2060
AUTOBRAKE 3	3250	235/-215	125/165	-180/655	260/-170	105/-105	100	705	2060

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

***For landing distance at or below 8000 ft pressure altitude, apply the STD adjustment. For altitudes higher than 8000 ft, first apply the STD adjustment to derive a new reference landing distance for 8000 ft then apply the HIGH adjustment to this new reference distance.**

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Reference Brake Energy (Millions of Foot Pounds)

Table 1(a) of 3: Sea Level to 10000 ft Pressure Altitude

		BRAKES ON SPEED (KIAS)																	
		80			100			120			140			160			180		
WEIGHT	OAT	PRESSURE ALTITUDE (1000 FT)																	
(1000 KG)	(°C)	0	5	10	0	5	10	0	5	10	0	5	10	0	5	10	0	5	10
90	0	16.6	18.8	21.5	24.6	28.2	32.5	33.9	39.2	45.6	44.2	51.4	60.0	55.3					
	10	17.1	19.5	22.2	25.4	29.1	33.6	35.0	40.5	47.1	45.7	53.2	62.0	57.2					
	15	17.4	19.8	22.6	25.8	29.6	34.1	35.6	41.2	47.8	46.4	54.0	63.0	58.1					
	20	17.7	20.1	22.9	26.2	30.1	34.7	36.1	41.8	48.6	47.2	54.9	64.0	59.0					
	30	18.2	20.6	23.6	26.9	30.9	35.7	37.2	43.0	50.0	48.6	56.5	66.0	60.8					
	40	18.2	20.7	23.7	27.1	31.1	36.0	37.5	43.5	50.8	49.2	57.5	67.3	61.9					
	50	18.2	20.7	23.7	27.2	31.3	36.3	37.8	44.0	51.5	49.9	58.4	68.6	63.0					
80	0	15.1	17.1	19.5	22.3	25.5	29.4	30.6	35.4	41.0	39.9	46.4	54.1	50.0	58.1		60.3		
	10	15.6	17.7	20.1	23.0	26.4	30.3	31.6	36.5	42.4	41.3	47.9	55.9	51.6	60.1		62.3		
	15	15.9	18.0	20.5	23.4	26.8	30.8	32.1	37.1	43.1	41.9	48.7	56.8	52.5	61.0		63.4		
	20	16.1	18.2	20.8	23.8	27.2	31.3	32.7	37.7	43.7	42.6	49.5	57.7	53.3	62.0		64.4		
	30	16.5	18.7	21.4	24.4	28.0	32.2	33.6	38.8	45.0	43.8	50.9	59.4	54.9	63.9		66.3		
	40	16.6	18.8	21.4	24.6	28.2	32.5	33.9	39.2	45.6	44.4	51.7	60.5	55.8	65.1		67.7		
	50	16.6	18.8	21.5	24.7	28.3	32.7	34.1	39.6	46.1	44.9	52.4	61.6	56.7	66.4		69.0		
70	0	13.7	15.5	17.6	20.0	22.9	26.2	27.3	31.4	36.4	35.5	41.1	47.8	44.4	51.7	60.3	53.8		
	10	14.1	16.0	18.2	20.7	23.6	27.1	28.2	32.5	37.6	36.7	42.5	49.4	45.9	53.4	62.3	55.6		
	15	14.3	16.2	18.4	21.0	24.0	27.5	28.7	33.0	38.2	37.2	43.2	50.2	46.6	54.3	63.3	56.5		
	20	14.6	16.5	18.7	21.3	24.4	27.9	29.1	33.5	38.8	37.8	43.8	51.0	47.4	55.1	64.3	57.4		
	30	15.0	16.9	19.2	21.9	25.0	28.7	29.9	34.5	39.9	38.9	45.1	52.5	48.8	56.8	66.3	59.1		
	40	15.0	17.0	19.3	22.0	25.2	28.9	30.2	34.8	40.3	39.3	45.7	53.3	49.5	57.7	67.6	60.2		
	50	15.0	17.0	19.3	22.1	25.3	29.1	30.3	35.1	40.7	39.7	46.2	54.1	50.1	58.7	69.0	61.2		
60	0	12.2	13.8	15.7	17.7	20.2	23.1	24.0	27.5	31.7	31.0	35.8	41.5	38.6	44.8	52.1	46.7	54.4	
	10	12.7	14.3	16.2	18.3	20.9	23.8	24.8	28.4	32.8	32.0	37.0	42.9	39.9	46.3	53.9	48.3	56.2	
	15	12.8	14.5	16.4	18.6	21.2	24.2	25.2	28.9	33.3	32.5	37.5	43.6	40.5	47.0	54.8	49.1	57.1	
	20	13.0	14.7	16.7	18.9	21.5	24.6	25.6	29.3	33.8	33.0	38.1	44.2	41.1	47.7	55.6	49.8	58.0	
	30	13.4	15.1	17.2	19.4	22.1	25.3	26.3	30.2	34.8	34.0	39.2	45.5	42.3	49.1	57.3	51.3	59.7	
	40	13.4	15.2	17.2	19.5	22.2	25.4	26.5	30.4	35.1	34.3	39.7	46.1	42.8	49.8	58.3	52.1	60.8	
	50	13.4	15.2	17.2	19.5	22.3	25.5	26.6	30.6	35.4	34.5	40.0	46.7	43.3	50.5	59.3	52.8	61.9	
50	0	10.8	12.2	13.8	15.5	17.5	20.0	20.7	23.6	27.1	26.5	30.4	35.2	32.7	37.8	44.0	39.4	45.8	53.3
	10	11.2	12.6	14.2	16.0	18.1	20.6	21.4	24.4	28.0	27.3	31.4	36.3	33.8	39.1	45.4	40.7	47.3	55.1
	15	11.4	12.8	14.5	16.2	18.4	21.0	21.7	24.8	28.5	27.8	31.9	36.9	34.4	39.7	46.2	41.4	48.1	56.0
	20	11.5	13.0	14.7	16.5	18.7	21.3	22.0	25.2	28.9	28.2	32.4	37.5	34.9	40.4	46.9	42.0	48.8	56.9
	30	11.9	13.3	15.1	16.9	19.2	21.9	22.7	25.9	29.7	29.0	33.4	38.6	35.9	41.5	48.3	43.3	50.3	58.6
	40	11.9	13.4	15.1	17.0	19.3	22.0	22.8	26.0	29.9	29.2	33.6	39.0	36.2	42.0	48.9	43.8	51.0	59.6
	50	11.9	13.4	15.1	17.0	19.3	22.0	22.8	26.1	30.1	29.4	33.9	39.3	36.5	42.4	49.6	44.3	51.7	60.7
40	0	9.4	10.6	11.9	13.2	14.9	16.9	17.3	19.7	22.5	21.9	25.1	28.8	26.8	30.8	35.7	32.0	37.0	42.9
	10	9.8	10.9	12.3	13.6	15.4	17.5	17.9	20.4	23.3	22.6	25.9	29.8	27.7	31.9	36.8	33.1	38.2	44.4
	15	9.9	11.1	12.5	13.8	15.6	17.7	18.2	20.7	23.6	23.0	26.3	30.2	28.1	32.4	37.4	33.6	38.8	45.1
	20	10.1	11.3	12.7	14.0	15.9	18.0	18.5	21.0	24.0	23.3	26.7	30.7	28.6	32.9	38.0	34.1	39.4	45.8
	30	10.3	11.6	13.1	14.4	16.3	18.5	19.0	21.6	24.7	24.0	27.5	31.6	29.4	33.8	39.1	35.1	40.6	47.1
	40	10.3	11.6	13.1	14.5	16.3	18.6	19.0	21.7	24.8	24.1	27.6	31.8	29.6	34.1	39.5	35.4	41.0	47.8
	50	10.3	11.6	13.1	14.4	16.3	18.6	19.1	21.7	24.9	24.2	27.8	32.0	29.8	34.4	39.9	35.7	41.4	48.4

To correct for wind, enter table with the brakes-on speed minus one-half the headwind or plus 1.5 times the tailwind. If ground speed is used for brakes-on speed, ignore wind and enter table with sea level, 15°C.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Reference Brake Energy (Millions of Foot Pounds)

Table 1(b) of 3: 10000 ft to 14500 ft Pressure Altitude

		BRAKES ON SPEED (KIAS)																	
		80			100			120			140			160			180		
WEIGHT	OAT	PRESSURE ALTITUDE (1000 FT)																	
(1000 KG)	(°C)	10	12	14.5	10	12	14.5	10	12	14.5	10	12	14.5	10	12	14.5	10	12	14.5
90	0	21.5	22.7	24.1	32.5	34.4	37.0	45.6	48.4	52.2	60.0								
	10	22.2	23.4	25.0	33.6	35.6	38.2	47.1	50.0	54.0	62.0								
	15	22.6	23.8	25.4	34.1	36.1	38.9	47.8	50.8	54.9	63.0								
	20	22.9	24.1	25.8	34.7	36.7	39.5	48.6	51.6	55.8	64.0								
	30	23.6	24.8	26.5	35.7	37.8	40.6	50.0	53.2	57.4	66.0								
	40	23.7	25.0	26.7	36.0	38.2	41.0	50.8	54.0	58.4	67.3								
	50	23.7	25.1	26.8	36.3	38.5	41.4	51.5	54.8	59.4	68.6								
80	0	19.5	20.5	21.9	29.4	31.1	33.3	41.0	43.5	46.9	54.1	57.5							
	10	20.1	21.2	22.6	30.3	32.1	34.4	42.4	45.0	48.5	55.9	59.4							
	15	20.5	21.5	22.9	30.8	32.6	35.0	43.1	45.7	49.3	56.8	60.4							
	20	20.8	21.9	23.3	31.3	33.1	35.5	43.7	46.4	50.1	57.7	61.4							
	30	21.4	22.5	23.9	32.2	34.1	36.5	45.0	47.8	51.5	59.4	63.2							
	40	21.4	22.6	24.1	32.5	34.4	36.9	45.6	48.4	52.3	60.5	64.4							
	50	21.5	22.7	24.1	32.7	34.6	37.2	46.1	49.1	53.1	61.6	65.7							
70	0	17.6	18.5	19.7	26.2	27.7	29.6	36.4	38.6	41.5	47.8	50.8	54.9	60.3					
	10	18.2	19.1	20.3	27.1	28.6	30.6	37.6	39.8	42.9	49.4	52.5	56.7	62.3					
	15	18.4	19.4	20.6	27.5	29.1	31.1	38.2	40.5	43.6	50.2	53.4	57.6	63.3					
	20	18.7	19.7	21.0	27.9	29.5	31.6	38.8	41.1	44.3	51.0	54.2	58.5	64.3					
	30	19.2	20.2	21.5	28.7	30.3	32.5	39.9	42.3	45.6	52.5	55.8	60.3	66.3					
	40	19.3	20.3	21.6	28.9	30.6	32.8	40.3	42.8	46.1	53.3	56.8	61.4	67.6					
	50	19.3	20.3	21.7	29.1	30.8	33.0	40.7	43.3	46.7	54.1	57.7	62.5	69.0					
60	0	15.7	16.5	17.5	23.1	24.3	26.0	31.7	33.6	36.0	41.5	44.0	47.5	52.1	55.4	59.9			
	10	16.2	17.0	18.0	23.8	25.1	26.9	32.8	34.7	37.3	42.9	45.5	49.1	53.9	57.3	61.9			
	15	16.4	17.3	18.3	24.2	25.5	27.3	33.3	35.3	37.9	43.6	46.2	49.9	54.8	58.2	62.9			
	20	16.7	17.5	18.6	24.6	25.9	27.7	33.8	35.8	38.5	44.2	47.0	50.7	55.6	59.2	63.9			
	30	17.2	18.0	19.1	25.3	26.7	28.5	34.8	36.8	39.6	45.5	48.4	52.1	57.3	60.9	65.9			
	40	17.2	18.1	19.2	25.4	26.8	28.7	35.1	37.2	40.0	46.1	49.0	52.9	58.3	62.1	67.2			
	50	17.2	18.1	19.2	25.5	27	28.8	35.4	37.5	40.4	46.7	49.7	53.7	59.3	63.2	68.5			
50	0	13.8	14.5	15.3	20.0	21.0	22.4	27.1	28.7	30.7	35.2	37.3	40.1	44.0	46.7	50.4	53.3	56.7	
	10	14.2	14.9	15.8	20.6	21.7	23.1	28.0	29.6	31.7	36.3	38.5	41.4	45.4	48.3	52.0	55.1	58.6	
	15	14.5	15.2	16.1	21.0	22.1	23.5	28.5	30.1	32.2	36.9	39.1	42.1	46.2	49.0	52.9	56.0	59.6	
	20	14.7	15.4	16.3	21.3	22.4	23.9	28.9	30.6	32.7	37.5	39.7	42.7	46.9	49.8	53.7	56.9	60.5	
	30	15.1	15.8	16.8	21.9	23.0	24.5	29.7	31.4	33.7	38.6	40.9	44.0	48.3	51.3	55.3	58.6	62.3	
	40	15.1	15.9	16.8	22.0	23.2	24.7	29.9	31.7	34.0	39.0	41.3	44.5	48.9	52.0	56.2	59.6	63.5	
	50	15.1	15.9	16.8	22.0	23.2	24.8	30.1	31.9	34.2	39.3	41.8	45.0	49.6	52.8	57.1	60.7	64.7	
40	0	11.9	12.5	13.2	16.9	17.8	18.9	22.5	23.8	25.4	28.8	30.5	32.7	35.7	37.8	40.7	42.9	45.6	49.2
	10	12.3	12.9	13.7	17.5	18.4	19.5	23.3	24.5	26.2	29.8	31.5	33.8	36.8	39.1	42.0	44.4	47.1	50.8
	15	12.5	13.1	13.9	17.7	18.6	19.8	23.6	24.9	26.6	30.2	32.0	34.3	37.4	39.7	42.7	45.1	47.9	51.6
	20	12.7	13.3	14.1	18.0	18.9	20.1	24.0	25.3	27.1	30.7	32.5	34.8	38.0	40.3	43.4	45.8	48.6	52.4
	30	13.1	13.7	14.5	18.5	19.5	20.7	24.7	26.0	27.8	31.6	33.4	35.8	39.1	41.5	44.6	47.1	50.1	54.0
	40	13.1	13.7	14.5	18.6	19.5	20.8	24.8	26.2	28.0	31.8	33.7	36.1	39.5	41.9	45.2	47.8	50.8	54.9
	50	13.1	13.7	14.5	18.6	19.6	20.8	24.9	26.3	28.1	32.0	33.9	36.4	39.9	42.4	45.7	48.4	51.5	55.7

To correct for wind, enter table with the brakes-on speed minus one-half the headwind or plus 1.5 times the tailwind. If ground speed is used for brakes-on speed, ignore wind and enter table with sea level, 15°C.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Event Adjusted Brake Energy (Millions of Foot Pounds)

Table 2(a) of 3: No Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)					
EVENT		10	20	30	40	50	60
RTO MAX MAN		10.0	20.0	30.0	40.0	50.0	60.0
LANDING	MAX MAN	7.9	16.4	25.5	35.0	44.8	54.8
	MAX AUTO	7.4	15.3	23.7	32.6	41.9	51.5
	AUTOBRAKE 3	7.4	15.1	23.2	31.7	40.6	49.8
	AUTOBRAKE 2	7.1	14.4	22.1	30.0	38.3	47.0
	AUTOBRAKE 1	6.6	13.3	20.1	27.1	34.3	41.8

Table 2(b) of 3: Two Engine Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)					
EVENT		10	20	30	40	50	60
RTO MAX MAN		10.0	20.0	30.0	40.0	50.0	60.0
LANDING	MAX MAN	7.2	15.2	23.7	32.6	41.8	51.0
	MAX AUTO	6.0	12.6	19.8	27.5	35.7	44.4
	AUTOBRAKE 3	5.4	11.3	17.7	24.7	32.1	40.0
	AUTOBRAKE 2	4.3	9.0	14.3	20.2	26.5	33.3
	AUTOBRAKE 1	2.4	5.2	8.4	12.0	16.1	20.6

Table 3 of 3: Cooling Time (Minutes)

	EVENT ADJUSTED BRAKE ENERGY (MILLIONS OF FOOT POUNDS)										
	16.4 & BELOW	17	19	20.9	22.4	23.5	25.1	26.9	28.2	29.9 TO 41	41 & ABOVE
GEAR DOWN INFLIGHT	NO SPECIAL PROCEDURE REQUIRED	1.0	4.0	5.0	5.6	6.0	6.5	7.0	7.3	CAUTION	FUSE PLUG MELT ZONE
GROUND		6.6	16.1	24.2	30	34.3	40	45.8	50		
BRAKE TEMPERATURE INDICATION	UP TO 2.5	2.6	3.0	3.3	3.6	3.8	4.1	4.5	4.7	*5.0 TO 7.1	7.1 & ABOVE

Observe maximum quick turnaround limit. Table shows energy per brake added by a single stop with all brakes operating. Energy is assumed to be equally distributed among the operating brakes. Total energy is the sum of residual energy plus energy added.

Add 1.0 million foot pounds for each taxi mile.

When in caution zone, wheel fuse plugs may melt. Delay takeoff and inspect after one hour. If overheat occurs after takeoff, extend gear soon for at least 7 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not approach gear or attempt taxi for one hour. Tire, wheel and brake replacement may be required. If overheat occurs after takeoff, extend gear soon for at least 12 minutes.

Brake temperature indication on Multifunction Display may be used 10 to 15 minutes after airplane has come to a complete stop, or in flight with gear retracted, to determine recommended cooling schedule.

***For airplanes with TBMS (combined Tire Pressure and Brake Temperature Monitoring System), the beginning of the caution range can vary from 5.0 to 6.2 depending on wheel temperature.**

Intentionally
Blank

Performance Inflight — Chapter PI
Engine Inoperative — Section 33

ENGINE INOP

Initial Max Continuous %N1

Based on .79M, A/C high and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT)								
	25	27	29	31	33	35	37	39	41
20	88.8	88.5	88.2	88.7	88.6	89.0	89.2	88.6	88.0
15	89.9	89.5	89.1	89.6	89.5	89.0	88.5	87.9	87.2
10	91.0	90.5	90.1	90.5	90.3	89.9	89.0	88.4	87.7
5	91.4	91.4	91.0	91.3	91.2	90.8	90.1	89.6	89.0
0	90.6	91.6	91.8	92.2	92.0	91.6	90.9	90.2	89.4
-5	89.7	90.7	91.7	92.8	92.6	92.3	91.5	90.8	89.9
-10	88.8	89.7	90.8	92.4	93.3	93.1	92.3	91.5	90.6
-15	88.0	88.9	89.9	91.5	92.9	93.9	93.1	92.4	91.5
-20	87.2	88.1	89.1	90.7	92.0	93.3	93.3	92.6	91.7
-25	86.4	87.3	88.2	89.8	91.2	92.4	92.4	91.7	90.9
-30	85.6	86.4	87.4	89.0	90.3	91.5	91.4	90.8	90.0
-35	84.7	85.6	86.5	88.1	89.4	90.5	90.5	89.9	89.2
-40	83.9	84.7	85.6	87.2	88.5	89.6	89.5	89.0	88.3

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	25	27	29	31	33	35	37	39	41
ENGINE ANTI-ICE	-0.8	-0.8	-1.0	-1.0	-1.3	-1.8	-2.0	-2.0	-1.9
ENGINE & WING ANTI-ICE	-3.3	-3.5	-3.7	-4.1	-4.9	-6.1	-6.2	-6.2	-6.0

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

37000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
160	.51	87.9	88.9	89.9	90.8	91.8	91.8	91.9	91.9	91.5	90.5	90.2	90.8
200	.63	87.7	88.7	89.7	90.6	91.6	92.5	92.8	92.8	92.4	91.6	90.6	90.1
240	.74	87.1	88.1	89.1	90.1	91.0	92.0	92.9	93.5	93.1	92.1	91.3	90.7
280	.86	85.3	86.3	87.3	88.2	89.2	90.1	91.0	91.9	92.8	92.6	91.8	91.2

35000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
160	.49	88.0	88.9	89.9	90.9	91.8	92.1	92.1	92.1	92.0	91.4	90.7	90.9
200	.60	87.2	88.1	89.1	90.0	91.0	91.9	92.3	92.3	92.3	92.3	91.4	90.7
240	.71	87.2	88.1	89.1	90.1	91.0	91.9	92.8	93.5	93.4	92.8	92.0	91.3
280	.82	86.1	87.0	88.0	88.9	89.8	90.8	91.7	92.6	93.4	93.2	92.4	91.7

33000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
160	.47	88.9	89.9	90.8	91.7	92.6	92.6	92.6	92.2	91.5	90.8	90.4	90.9
200	.58	88.5	89.4	90.3	91.3	92.2	93.1	93.1	92.6	92.1	91.6	90.9	90.2
240	.68	87.8	88.7	89.7	90.6	91.5	92.4	93.3	93.4	92.8	92.2	91.6	90.6
280	.79	86.7	87.6	88.5	89.4	90.3	91.2	92.1	92.9	93.3	92.6	92.0	91.2
320	.89	85.3	86.2	87.1	88.0	88.9	89.8	90.6	91.5	92.3	93.3	93.1	92.3

31000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
160	.45	88.7	89.6	90.5	91.5	92.4	92.9	92.9	92.5	91.7	90.9	90.3	90.0
200	.55	88.5	89.4	90.4	91.3	92.2	93.1	93.6	93.2	92.3	91.6	91.0	90.1
240	.66	87.6	88.6	89.5	90.4	91.3	92.2	93.1	93.7	93.1	92.2	91.6	90.7
280	.76	86.1	87.0	87.9	88.8	89.6	90.5	91.4	92.2	93.1	92.7	92.1	91.2
320	.85	84.0	85.0	85.9	86.7	87.6	88.4	89.3	90.1	90.9	91.9	92.4	91.7

29000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
160	.43	89.0	89.9	90.8	91.7	92.6	92.9	92.3	91.3	90.5	89.8	88.9	89.0
200	.53	88.6	89.6	90.5	91.4	92.3	93.2	93.1	92.2	91.3	90.5	89.4	88.5
240	.63	87.9	88.9	89.8	90.7	91.6	92.4	93.3	92.9	92.0	91.1	90.1	89.0
280	.73	86.1	87.0	87.9	88.8	89.6	90.5	91.3	92.2	92.4	91.6	90.7	89.7
320	.82	84.0	84.9	85.8	86.6	87.5	88.3	89.1	90.0	90.9	91.8	91.1	90.3
360	.91	83.5	84.4	85.3	86.2	87.0	87.8	88.7	89.5	90.4	91.3	91.9	92.0

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	37	35	33	31	29
ENGINE ANTI-ICE	-2.0	-1.8	-1.3	-1.0	-1.0
ENGINE & WING ANTI-ICE	-6.1	-5.9	-4.8	-3.9	-3.6

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

27000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
160	.41	89.0	89.9	90.8	91.8	92.7	93.5	93.1	91.8	90.9	90.3	89.2	88.2
200	.51	88.2	89.1	90.0	90.9	91.8	92.7	93.3	92.5	91.7	91.0	89.8	88.7
240	.60	87.4	88.3	89.2	90.1	91.0	91.9	92.7	93.4	92.4	91.6	90.6	89.5
280	.70	85.7	86.6	87.5	88.4	89.2	90.1	90.9	91.7	92.7	92.1	91.1	90.0
320	.79	83.8	84.7	85.6	86.4	87.2	88.1	88.9	89.7	90.7	91.6	91.4	90.5
360	.88	82.6	83.5	84.4	85.2	86.1	86.9	87.7	88.5	89.4	90.4	91.1	91.6

25000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
160	.39	90.1	91.0	91.9	92.7	93.6	93.7	92.4	91.4	90.7	89.7	88.5	88.0
200	.49	88.9	89.8	90.7	91.6	92.5	93.3	93.1	92.1	91.3	90.3	89.1	88.0
240	.58	87.7	88.6	89.4	90.3	91.1	92.0	92.8	92.8	91.9	90.9	89.8	88.6
280	.67	86.2	87.0	87.9	88.8	89.6	90.4	91.2	92.2	92.4	91.5	90.4	89.2
320	.76	84.4	85.3	86.1	87.0	87.8	88.6	89.4	90.3	91.2	91.8	90.8	89.7
360	.85	82.6	83.4	84.3	85.1	85.9	86.7	87.5	88.3	89.2	90.0	90.7	90.2

24000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
160	.38	90.0	90.9	91.8	92.7	93.6	94.5	93.1	92.0	91.2	90.2	89.1	88.1
200	.48	89.9	90.8	91.7	92.6	93.5	94.4	94.7	93.2	92.2	91.3	90.1	89.1
240	.57	89.4	90.3	91.2	92.1	93.0	93.9	94.7	94.9	93.2	92.2	91.1	90.0
280	.66	87.2	88.1	89.0	89.9	90.7	91.6	92.4	93.3	93.8	92.7	91.7	90.6
320	.75	85.3	86.2	87.1	87.9	88.8	89.6	90.4	91.2	92.1	92.9	92.1	91.1
360	.83	83.5	84.4	85.2	86.1	86.9	87.7	88.5	89.3	90.1	90.9	91.7	91.6

22000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
160	.37	89.9	90.8	91.7	92.5	93.4	93.6	92.3	91.4	90.4	89.3	88.2	87.6
200	.46	89.5	90.4	91.3	92.2	93.0	93.9	93.5	92.4	91.4	90.3	89.2	88.1
240	.55	91.6	92.5	93.4	94.3	95.2	96.1	97.0	95.8	94.2	93.1	92.0	90.9
280	.63	89.5	90.5	91.3	92.2	93.1	94.0	94.8	95.7	95.0	93.6	92.5	91.5
320	.72	87.2	88.1	89.0	89.9	90.7	91.6	92.4	93.2	94.0	94.0	93.0	92.0
360	.80	85.3	86.2	87.1	87.9	88.7	89.6	90.4	91.2	92.0	92.8	93.3	92.4

20000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
160	.35	89.2	90.0	90.8	91.7	92.5	93.4	92.8	91.8	90.7	89.5	88.3	87.2
200	.44	88.4	89.3	90.1	90.9	91.7	92.6	93.4	92.4	91.3	90.1	88.9	87.8
240	.53	91.5	92.4	93.2	94.1	94.9	95.8	96.7	97.4	96.1	94.9	93.7	92.6
280	.61	90.8	91.7	92.6	93.4	94.3	95.1	95.9	96.8	97.5	96.0	94.7	93.7
320	.69	88.9	89.8	90.7	91.5	92.3	93.1	93.9	94.7	95.5	96.4	95.2	94.2
360	.77	86.7	87.6	88.5	89.3	90.1	90.9	91.6	92.4	93.2	94.0	94.8	94.4

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	27	25	24	22	20
ENGINE ANTI-ICE	-0.8	-0.8	-0.9	-1.0	-1.1
ENGINE & WING ANTI-ICE	-3.4	-3.3	-3.1	-3.5	-3.5

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

18000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
160	.34	88.5	89.3	90.1	90.9	91.8	92.7	92.1	91.1	89.9	88.7	87.5	86.2
200	.42	87.7	88.5	89.4	90.2	91.0	91.8	92.3	91.7	90.4	89.2	88.1	87.1
240	.51	90.4	91.3	92.1	93.0	93.8	94.7	95.5	95.8	94.9	93.7	92.6	91.6
280	.59	92.2	93.1	93.9	94.8	95.6	96.5	97.3	98.2	97.8	96.2	95.1	94.1
320	.67	90.2	91.1	92.0	92.8	93.6	94.4	95.2	96.1	96.9	96.7	95.5	94.6
360	.75	88.0	88.9	89.7	90.5	91.3	92.1	92.9	93.7	94.5	95.3	95.7	94.9

16000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
160	.33	87.6	88.5	89.3	90.1	90.9	91.8	92.3	91.4	90.2	89.0	87.9	86.7
200	.41	87.2	88.0	88.9	89.7	90.5	91.3	92.1	91.9	90.8	89.6	88.4	87.3
240	.49	88.1	88.9	89.8	90.6	91.4	92.2	93.1	93.9	93.8	92.8	91.6	90.6
280	.57	92.0	92.9	93.8	94.6	95.5	96.3	97.1	98.0	98.9	97.4	96.1	95.2
320	.64	90.3	91.2	92.0	92.9	93.7	94.5	95.4	96.2	97.0	97.9	96.5	95.6
360	.72	87.7	88.6	89.5	90.3	91.1	91.9	92.7	93.5	94.2	95.1	95.9	95.5

14000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
160	.31	88.3	89.1	89.9	90.7	91.6	92.4	92.4	91.4	90.2	89.1	88.0	87.2
200	.39	87.9	88.7	89.6	90.4	91.2	92.0	92.8	91.9	90.7	89.6	88.6	87.5
240	.47	87.5	88.4	89.2	90.0	90.8	91.6	92.4	93.2	92.6	91.5	90.4	89.4
280	.54	91.6	92.5	93.4	94.2	95.0	95.9	96.7	97.5	97.7	96.4	95.4	94.5
320	.62	90.4	91.4	92.2	93.0	93.9	94.7	95.5	96.3	97.1	97.2	96.0	95.2
360	.69	87.6	88.4	89.3	90.1	90.9	91.7	92.5	93.2	94.0	94.8	95.2	94.7

12000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	35
160	.30	89.5	90.3	91.2	92.0	92.8	93.7	93.3	92.2	91.2	90.2	89.2	88.2
200	.38	89.1	89.9	90.7	91.5	92.3	93.2	93.7	92.8	91.6	90.7	89.6	88.6
240	.45	88.1	88.9	89.8	90.6	91.3	92.2	93.0	93.0	92.2	91.2	90.2	89.2
280	.52	91.0	91.9	92.7	93.5	94.4	95.2	96.0	96.9	96.4	95.5	94.5	93.6
320	.60	90.1	91.0	91.9	92.7	93.5	94.3	95.1	96.0	96.8	96.1	95.1	94.2
360	.67	86.5	87.4	88.2	89.0	89.8	90.5	91.3	92.1	92.9	93.6	93.8	93.5

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	18	16	14	12
ENGINE ANTI-ICE	-1.2	-1.2	-1.0	-1.1
ENGINE & WING ANTI-ICE	-3.7	-3.3	-3.0	-3.0

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

10000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	35
160	.29	89.8	90.7	91.5	92.3	93.2	94.0	94.8	94.2	93.2	92.3	91.3	90.4
200	.36	89.3	90.1	90.9	91.8	92.6	93.4	94.2	94.4	93.7	92.7	91.7	90.8
240	.43	88.6	89.5	90.3	91.1	91.9	92.8	93.6	94.4	94.1	93.2	92.2	91.2
280	.51	90.3	91.1	92.0	92.8	93.6	94.5	95.3	96.1	96.7	95.7	94.7	93.8
320	.58	88.8	89.7	90.5	91.3	92.1	92.9	93.7	94.5	95.4	95.8	95.1	94.2
360	.65	84.7	85.5	86.3	87.1	87.9	88.7	89.4	90.2	90.9	91.7	92.2	92.2

5000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-15	-10	-5	0	5	10	15	20	25	30	35	40
160	.26	89.3	90.2	91.0	91.9	92.7	93.6	94.1	93.2	92.3	91.3	90.3	89.4
200	.33	89.0	89.9	90.7	91.6	92.4	93.3	94.1	93.6	92.6	91.7	90.7	89.7
240	.40	88.5	89.3	90.2	91.0	91.9	92.7	93.5	94.0	93.1	92.2	91.2	90.2
280	.46	87.9	88.7	89.6	90.4	91.2	92.1	92.9	93.7	93.7	92.8	91.9	90.9
320	.53	86.0	86.8	87.6	88.4	89.3	90.1	90.9	91.6	92.4	92.5	92.2	91.7
360	.59	81.5	82.3	83.1	83.8	84.6	85.4	86.1	86.9	87.6	88.4	88.4	88.4

3000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-5	0	5	10	15	20	25	30	35	40	45	50
160	.26	89.0	89.8	90.6	91.4	92.3	93.1	93.2	92.3	91.4	90.4	89.4	88.5
200	.32	88.6	89.4	90.3	91.1	91.9	92.7	93.6	92.7	91.7	90.7	89.7	88.8
240	.38	88.1	88.9	89.7	90.6	91.4	92.2	93.0	93.0	92.2	91.2	90.2	89.3
280	.45	87.5	88.3	89.1	89.9	90.7	91.5	92.3	93.1	92.5	91.6	90.6	89.8
320	.51	84.7	85.5	86.3	87.1	87.9	88.6	89.4	90.2	90.9	90.9	90.8	90.5
360	.57	80.5	81.3	82.0	82.7	83.5	84.2	84.9	85.7	86.4	86.9	86.9	86.9

1000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-5	0	5	10	15	20	25	30	35	40	45	50
160	.25	87.7	88.6	89.4	90.2	91.0	91.8	92.6	92.3	91.4	90.5	89.5	88.6
200	.31	87.4	88.2	89.0	89.8	90.6	91.5	92.3	92.6	91.7	90.7	89.8	88.8
240	.37	86.9	87.7	88.5	89.3	90.1	90.9	91.7	92.5	92.1	91.2	90.2	89.2
280	.43	85.2	86.0	86.8	87.6	88.4	89.2	89.9	90.7	91.3	91.0	90.4	89.7
320	.49	82.6	83.4	84.2	84.9	85.7	86.4	87.2	88.0	88.7	89.1	89.0	89.0
360	.55	78.8	79.5	80.3	81.0	81.7	82.5	83.2	83.9	84.6	85.3	85.5	85.5

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	10	5	3	1
ENGINE ANTI-ICE	-1.1	0.0	0.0	0.0
ENGINE & WING ANTI-ICE	-2.8	0.0	0.0	0.0

ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

100 ft/min residual rate of climb

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF PRESSURE ALTITUDE		
START DRIFTDOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
85	82	254	18400	16800	14000
80	77	247	19900	18600	16300
75	72	239	21100	20300	19000
70	68	232	22400	21600	20700
65	63	223	23900	23000	22100
60	58	215	25500	24500	23700
55	53	206	27600	26700	25600
50	48	197	29900	29000	28200
45	43	188	32200	31700	31200
40	38	179	34600	34200	33800

Includes APU fuel burn.

ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown/LRC Cruise Range Capability

Table 1 of 2: Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
142	131	121	113	106	100	94	89	84	80	77
283	261	243	226	212	200	188	178	169	161	154
425	392	364	340	318	300	283	268	254	242	231
566	522	485	453	424	400	377	357	340	323	309
706	652	606	566	531	500	472	447	425	405	386
846	782	727	679	637	600	566	537	510	486	464
986	911	847	792	743	700	661	627	596	568	542
1126	1041	968	904	849	800	756	716	681	649	620
1265	1170	1088	1017	955	900	850	806	767	731	698
1404	1299	1209	1130	1061	1000	945	896	852	812	776
1544	1428	1329	1243	1167	1100	1040	986	938	894	854
1683	1557	1449	1355	1273	1200	1134	1076	1023	975	932
1822	1687	1570	1468	1379	1300	1229	1166	1109	1057	1010
1962	1816	1690	1581	1485	1400	1324	1256	1194	1138	1088
2101	1945	1811	1693	1591	1500	1418	1345	1280	1220	1166
2241	2075	1931	1806	1697	1600	1513	1435	1365	1301	1244
2381	2204	2052	1919	1803	1700	1607	1525	1450	1383	1321
2521	2334	2173	2032	1909	1800	1702	1615	1536	1464	1399

Table 2 of 2: Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 KG)										TIME (HR:MIN)
	WEIGHT AT START OF DRIFTDOWN (1000 KG)										
	40	45	50	55	60	65	70	75	80	85	
100	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0:18
200	0.7	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.1	1.1	0:35
300	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.6	1.8	1.9	0:53
400	1.4	1.6	1.7	1.8	1.9	2.0	2.2	2.3	2.5	2.6	1:10
500	1.8	1.9	2.1	2.3	2.4	2.6	2.8	2.9	3.1	3.3	1:28
600	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.8	4.0	1:45
700	2.5	2.7	2.9	3.2	3.4	3.6	3.9	4.1	4.4	4.7	2:02
800	2.8	3.1	3.4	3.6	3.9	4.2	4.5	4.7	5.1	5.3	2:19
900	3.2	3.5	3.8	4.1	4.4	4.7	5.0	5.3	5.7	6.0	2:36
1000	3.5	3.9	4.2	4.5	4.9	5.2	5.6	5.9	6.3	6.7	2:53
1100	3.8	4.2	4.6	5.0	5.3	5.7	6.1	6.5	6.9	7.3	3:10
1200	4.2	4.6	5.0	5.4	5.8	6.3	6.7	7.1	7.5	8.0	3:27
1300	4.5	5.0	5.4	5.9	6.3	6.8	7.2	7.7	8.2	8.6	3:44
1400	4.8	5.3	5.8	6.3	6.8	7.3	7.8	8.2	8.8	9.3	4:01
1500	5.2	5.7	6.2	6.7	7.3	7.8	8.3	8.8	9.4	9.9	4:18
1600	5.5	6.1	6.6	7.2	7.7	8.3	8.9	9.4	10.0	10.6	4:35
1700	5.8	6.4	7.0	7.6	8.2	8.8	9.4	10.0	10.6	11.2	4:52
1800	6.2	6.8	7.4	8.0	8.7	9.3	9.9	10.5	11.2	11.8	5:09

Includes APU fuel burn.
Driftdown at optimum driftdown speed and cruise at Long Range Cruise speed.

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability

100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
85	16600	14900	11800
80	18100	16500	14700
75	19700	18100	16500
70	20900	19700	18100
65	22200	21000	19900
60	23500	22300	21300
55	24900	23800	22800
50	27500	25700	24400
45	30200	28600	27100
40	32700	31800	30700

With engine anti-ice on, decrease altitude capability by 1300 ft.
With engine and wing anti-ice on, decrease altitude capability by 5700 ft.

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)									
		10	15	17	19	21	23	25	27	29	31
85	%N1	87.8	91.7	93.4							
	MACH	.545	.587	.599							
	KIAS	302	297	292							
	FF/ENG	2674	2647	2625							
80	%N1	86.1	90.3	91.8	93.7						
	MACH	.529	.577	.590	.602						
	KIAS	293	292	287	282						
	FF/ENG	2512	2508	2487	2471						
75	%N1	84.3	88.6	90.2	91.7						
	MACH	.513	.562	.580	.593						
	KIAS	284	284	282	277						
	FF/ENG	2352	2357	2348	2328						
70	%N1	82.4	86.7	88.4	90.1	91.7					
	MACH	.496	.545	.565	.582	.595					
	KIAS	275	275	275	272	267					
	FF/ENG	2193	2202	2200	2188	2169					
65	%N1	80.2	84.6	86.4	88.2	89.8	91.6				
	MACH	.479	.527	.547	.567	.584	.596				
	KIAS	265	266	266	265	262	257				
	FF/ENG	2034	2041	2046	2043	2031	2012				
60	%N1	77.9	82.4	84.2	86.0	87.8	89.4				
	MACH	.462	.507	.527	.548	.568	.585				
	KIAS	255	255	256	256	255	252				
	FF/ENG	1881	1883	1886	1890	1886	1875				
55	%N1	75.4	79.9	81.8	83.6	85.4	87.2	88.9			
	MACH	.444	.486	.505	.526	.547	.567	.585			
	KIAS	245	245	245	245	245	244	242			
	FF/ENG	1734	1726	1728	1730	1733	1729	1720			
50	%N1	72.8	77.2	79.1	81.0	82.8	84.7	86.5	88.3	90.4	
	MACH	.425	.465	.483	.502	.523	.544	.565	.584	.597	
	KIAS	235	234	233	234	234	234	233	231	227	
	FF/ENG	1590	1574	1572	1573	1574	1575	1572	1568	1559	
45	%N1	70.0	74.3	76.1	78.0	79.9	81.8	83.7	85.6	87.3	89.4
	MACH	.406	.443	.460	.478	.497	.518	.540	.561	.581	.595
	KIAS	224	223	222	222	222	222	222	222	220	216
	FF/ENG	1452	1429	1423	1418	1418	1416	1418	1419	1417	1408
40	%N1	67.0	71.1	72.9	74.8	76.6	78.5	80.5	82.4	84.3	86.2
	MACH	.387	.421	.436	.453	.470	.489	.510	.532	.555	.576
	KIAS	213	211	210	210	210	209	210	210	210	209
	FF/ENG	1328	1286	1281	1271	1265	1262	1260	1262	1265	1264

Includes APU fuel burn.

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
300	273	249	230	214	200	190	180	172	164	157
605	550	502	463	430	400	380	361	344	328	314
911	828	755	696	645	600	569	540	514	491	470
1219	1107	1010	929	861	800	759	721	686	655	627
1529	1388	1264	1162	1076	1000	948	900	857	818	783
1840	1668	1519	1396	1292	1200	1137	1080	1028	981	939
2153	1951	1775	1630	1508	1400	1327	1259	1198	1143	1094
2468	2235	2032	1865	1724	1600	1516	1439	1369	1306	1250
2785	2520	2289	2100	1940	1800	1705	1618	1540	1469	1406
3104	2806	2547	2335	2157	2000	1895	1798	1710	1631	1561

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		26	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	1.2	0:43	1.1	0:41	1.0	0:39	0.9	0:38	0.8	0:37
400	2.4	1:25	2.3	1:20	2.1	1:16	1.9	1:12	1.8	1:10
600	3.7	2:06	3.4	1:59	3.2	1:53	3.0	1:47	2.8	1:44
800	4.9	2:48	4.6	2:39	4.3	2:30	4.0	2:22	3.8	2:17
1000	6.2	3:31	5.8	3:19	5.4	3:07	5.0	2:57	4.8	2:51
1200	7.4	4:14	6.9	4:00	6.5	3:45	6.1	3:32	5.7	3:25
1400	8.6	4:57	8.0	4:40	7.5	4:23	7.1	4:08	6.7	3:59
1600	9.8	5:41	9.2	5:22	8.6	5:02	8.1	4:44	7.6	4:33
1800	11.0	6:25	10.3	6:03	9.6	5:41	9.1	5:20	8.6	5:08
2000	12.1	7:10	11.4	6:45	10.7	6:20	10.0	5:57	9.5	5:42

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	40	50	60	70	80
1	-0.1	-0.1	0.0	0.1	0.3
2	-0.3	-0.1	0.0	0.3	0.7
3	-0.4	-0.2	0.0	0.5	1.1
4	-0.6	-0.3	0.0	0.6	1.5
5	-0.7	-0.4	0.0	0.8	1.8
6	-0.9	-0.5	0.0	0.9	2.2
7	-1.0	-0.5	0.0	1.0	2.5
8	-1.2	-0.6	0.0	1.2	2.8
9	-1.3	-0.7	0.0	1.3	3.1
10	-1.5	-0.8	0.0	1.4	3.3
11	-1.6	-0.8	0.0	1.5	3.6
12	-1.8	-0.9	0.0	1.6	3.8
13	-1.9	-1.0	0.0	1.7	4.0
14	-2.1	-1.1	0.0	1.8	4.2

Includes APU fuel burn.

ENGINE INOP

MAX CONTINUOUS THRUST

Holding

Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)							
		1500	5000	10000	15000	20000	25000	30000	35000
85	%N1	75.8	79.2	84.0	88.9				
	KIAS	244	244	246	247				
	FF/ENG	2360	2370	2400	2450				
80	%N1	73.9	77.2	82.2	86.9	93.2			
	KIAS	237	237	238	239	242			
	FF/ENG	2230	2230	2250	2280	2390			
75	%N1	71.9	75.1	80.2	84.9	90.3			
	KIAS	229	229	230	232	233			
	FF/ENG	2100	2080	2100	2130	2190			
70	%N1	69.8	73.0	78.0	82.8	88.0			
	KIAS	220	222	222	224	225			
	FF/ENG	1970	1950	1960	1970	2010			
65	%N1	67.7	70.7	75.6	80.6	85.6			
	KIAS	211	214	214	215	216			
	FF/ENG	1830	1820	1810	1830	1850			
60	%N1	65.4	68.3	73.1	78.2	83.1	88.7		
	KIAS	204	204	206	206	208	209		
	FF/ENG	1690	1690	1670	1680	1700	1740		
55	%N1	63.0	65.9	70.4	75.5	80.6	85.7		
	KIAS	198	198	198	198	199	200		
	FF/ENG	1570	1550	1540	1540	1550	1570		
50	%N1	60.5	63.3	67.7	72.5	77.7	82.7	89.2	
	KIAS	191	191	191	191	191	191	192	
	FF/ENG	1450	1430	1420	1400	1410	1410	1470	
45	%N1	57.8	60.5	64.9	69.6	74.7	79.7	85.0	
	KIAS	185	185	185	185	185	185	185	
	FF/ENG	1330	1320	1300	1280	1270	1270	1290	
40	%N1	55.0	57.5	61.9	66.4	71.3	76.6	81.6	88.4
	KIAS	178	178	178	178	178	178	178	178
	FF/ENG	1220	1210	1190	1170	1160	1140	1150	1200

This table includes 5% additional fuel for holding in a racetrack pattern.
Includes APU fuel burn.

ENGINE INOP

ADVISORY INFORMATION

Gear Down Landing Rate of Climb Available

Flaps 15

TAT (°C)	RATE OF CLIMB (FT/MIN)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
54	-70	-140							
52	-30	-110							
50	0	-80	-190						
48	40	-50	-160						
46	80	-10	-120	-240					
44	110	30	-90	-200					
42	150	70	-50	-170	-290				
40	190	110	-10	-140	-260				
38	230	140	20	-110	-240	-360			
36	250	180	60	-80	-210	-340			
34	250	220	90	-50	-190	-320	-450		
32	250	230	120	-20	-160	-300	-420		
30	250	230	160	10	-130	-270	-400	-570	
20	250	240	160	80	-30	-140	-290	-460	-670
10	250	240	160	80	-30	-130	-220	-360	-580
0	250	240	160	80	-30	-130	-220	-370	-530
-20	260	250	170	80	-30	-130	-230	-380	-550
-40	270	260	180	80	-40	-140	-240	-390	-570
-50	270	260	180	80	-40	-140	-250	-400	-580
-54	280	270	180	80	-40	-140	-250	-410	-590

Rate of climb capability shown is valid for 65000 kg, gear down at VREF15+5.
Decrease rate of climb 100 ft/min per 5000 kg greater than 65000 kg.
Increase rate of climb 160 ft/min per 5000 kg less than 65000 kg.

ENGINE INOP

ADVISORY INFORMATION

Gear Down Landing Rate of Climb Available

Flaps 30

TAT (°C)	RATE OF CLIMB (FT/MIN)								
	PRESSURE ALTITUDE (FT)								
	-2000	0	2000	4000	6000	8000	10000	12000	14500
54	-310	-390							
52	-280	-360							
50	-250	-330	-440						
48	-210	-300	-410						
46	-180	-260	-380	-490					
44	-140	-230	-350	-460					
42	-110	-190	-310	-430	-550				
40	-70	-160	-280	-400	-530				
38	-40	-120	-240	-370	-500	-630			
36	-10	-90	-210	-340	-480	-610			
34	-20	-50	-180	-320	-460	-590	-720		
32	-20	-30	-150	-290	-430	-570	-700		
30	-20	-30	-120	-260	-410	-550	-680	-850	
20	-20	-40	-120	-200	-310	-430	-570	-750	-960
10	-20	-40	-120	-210	-310	-410	-510	-650	-880
0	-20	-40	-120	-210	-320	-420	-520	-660	-830
-20	-30	-40	-120	-220	-330	-440	-540	-680	-860
-40	-30	-50	-130	-230	-350	-460	-560	-710	-890
-50	-40	-50	-130	-240	-360	-470	-580	-730	-910
-54	-40	-50	-140	-240	-360	-470	-580	-740	-920

Rate of climb capability shown is valid for 65000 kg, gear down at VREF30+5.
Decrease rate of climb 100 ft/min per 5000 kg greater than 65000 kg.
Increase rate of climb 160 ft/min per 5000 kg less than 65000 kg.

ALTERNATE MODE EEC

Alternate Mode EEC Limit Weight

PERFORMANCE LIMIT	NORMAL MODE PERFORMANCE LIMIT WEIGHT (1000 KG)										
	40	45	50	55	60	65	70	75	80	85	90
CLIMB	39.9	44.9	49.9	54.9	59.9	64.9	69.9	74.9	79.9	84.9	89.9
OBSTACLE	39.6	44.6	49.6	54.6	59.6	64.6	69.6	74.6	79.6	84.6	89.6
BRAKE ENERGY	40.0	45.0	50.0	55.0	60.0	64.6	69.5	74.3	79.2	84.0	88.9

No adjustments to the takeoff speeds for the reduced weight are necessary.

ALTERNATE MODE EEC

Alternate Mode EEC Max Takeoff %N1

Based on engine bleeds for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
60	85.2	85.7	86.2	86.2	86.3	86.3	86.3	86.3	86.3	86.3	86.1	85.7	85.3	84.4	83.4	82.3	81.1	80.5
55	86.7	87.1	87.5	87.5	87.6	87.6	87.6	87.6	87.6	87.6	87.4	87.0	86.7	85.7	84.8	83.6	82.5	81.9
50	88.2	88.6	89.0	88.9	88.9	88.9	88.9	88.9	88.9	88.9	88.7	88.3	87.9	87.0	86.1	84.9	83.8	83.2
45	89.6	90.0	90.4	90.4	90.3	90.3	90.2	90.1	90.1	90.2	89.9	89.5	89.2	88.3	87.3	86.2	85.1	84.5
40	90.9	91.4	91.8	91.8	91.7	91.7	91.6	91.5	91.4	91.3	91.1	90.8	90.4	89.5	88.6	87.4	86.3	85.7
35	92.2	92.7	93.2	93.2	93.1	93.0	92.8	92.7	92.5	92.2	92.0	91.8	91.6	90.6	89.7	88.6	87.6	87.0
30	91.8	93.2	94.5	94.3	94.3	94.1	93.9	93.7	93.4	93.1	92.8	92.6	92.4	91.6	90.8	89.8	88.8	88.3
25	91.0	92.3	93.6	94.2	94.8	95.0	94.8	94.6	94.3	94.0	93.7	93.5	93.3	92.5	91.7	90.8	89.9	89.5
20	90.2	91.5	92.8	93.3	93.9	94.5	94.9	95.3	95.1	94.8	94.4	94.2	94.2	93.4	92.6	91.7	90.9	90.5
15	89.4	90.7	91.9	92.5	93.0	93.6	94.1	94.5	94.9	95.2	95.5	95.3	94.9	94.0	93.2	92.5	91.7	91.3
10	88.6	89.9	91.1	91.6	92.2	92.8	93.3	93.7	94.0	94.4	95.0	95.7	96.3	95.3	94.1	93.1	92.3	92.0
5	87.8	89.0	90.3	90.8	91.4	92.0	92.5	92.8	93.2	93.5	94.1	94.9	95.5	95.3	95.2	94.8	93.7	93.1
0	86.9	88.2	89.5	90.0	90.6	91.1	91.6	91.9	92.3	92.7	93.3	94.1	94.6	94.5	94.3	94.2	94.2	94.2
-5	86.1	87.4	88.6	89.2	89.7	90.3	90.7	91.1	91.4	91.8	92.4	93.2	93.7	93.6	93.5	93.4	93.3	93.3
-10	85.2	86.5	87.8	88.3	88.9	89.4	89.9	90.2	90.5	90.9	91.5	92.3	92.9	92.8	92.6	92.5	92.5	92.4
-15	84.4	85.7	87.0	87.5	88.1	88.5	89.0	89.3	89.7	90.1	90.7	91.5	92.1	91.9	91.8	91.7	91.6	91.6
-20	83.6	84.9	86.1	86.6	87.2	87.7	88.1	88.4	88.8	89.2	89.8	90.6	91.2	91.1	90.9	90.8	90.8	90.7
-25	82.8	84.0	85.3	85.8	86.4	86.8	87.3	87.6	87.9	88.3	89.0	89.8	90.3	90.2	90.1	90.0	89.9	89.9
-30	82.0	83.2	84.4	84.9	85.5	86.0	86.4	86.7	87.0	87.4	88.1	88.9	89.5	89.4	89.2	89.1	89.1	89.0
-35	81.1	82.3	83.6	84.1	84.7	85.1	85.5	85.8	86.2	86.6	87.2	88.0	88.5	88.5	88.3	88.3	88.2	88.2
-40	80.3	81.5	82.7	83.2	83.8	84.2	84.6	84.9	85.3	85.7	86.3	87.1	87.6	87.5	87.4	87.4	87.3	87.3
-45	79.4	80.6	81.8	82.3	82.9	83.3	83.7	84.0	84.4	84.8	85.4	86.1	86.7	86.6	86.5	86.5	86.4	86.4
-50	78.6	79.7	80.9	81.4	82.0	82.4	82.8	83.1	83.4	83.9	84.4	85.2	85.7	85.7	85.6	85.6	85.5	85.5

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.7	0.8	0.8	0.9	1.0	0.9	1.0	1.0	1.1	1.2	1.4	1.4	1.6	1.8	2.0	2.0	2.0	2.1
ENGINE ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.4	-0.9	-0.9	-0.9	-0.8	-0.9	-0.9

ALTERNATE MODE EEC

Alternate Mode EEC Max Climb %N1

Based on engine bleed for packs on and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KIAS OR MACH)											
	0	5	10	15	20	25	30	33	35	37	39	41
	280	280	280	280	280	280	280	0.78	0.78	0.78	0.78	0.78
60	82.2	82.7	85.2	87.2	89.4	91.3	94.0	95.5	96.5	96.9	96.3	95.6
55	83.2	83.0	84.5	86.5	88.8	90.6	93.3	94.8	95.8	96.1	95.5	94.9
50	84.1	84.0	84.0	85.8	88.1	89.9	92.6	94.0	95.1	95.4	94.8	94.2
45	85.1	85.0	84.9	85.2	87.4	89.2	91.9	93.3	94.3	94.7	94.1	93.5
40	86.1	86.1	86.1	85.5	86.7	88.5	91.2	92.6	93.6	93.9	93.3	92.7
35	86.8	87.1	87.1	86.6	86.4	87.8	90.4	91.8	92.9	93.2	92.6	92.0
30	86.0	88.0	88.1	87.7	87.1	87.1	89.7	91.1	92.1	92.4	91.8	91.2
25	85.3	88.1	89.0	88.6	88.0	87.8	88.9	90.3	91.3	91.6	91.1	90.5
20	84.6	87.4	90.0	89.6	89.0	88.7	89.4	89.8	90.6	90.9	90.3	89.7
15	83.8	86.6	89.4	90.6	90.0	89.8	90.2	90.5	90.3	90.1	89.5	88.9
10	83.1	85.8	88.6	91.0	91.1	90.9	91.1	91.3	91.0	90.3	89.7	89.2
5	82.3	85.1	87.9	90.2	92.2	91.9	91.9	92.0	91.8	91.1	90.7	90.1
0	81.5	84.3	87.1	89.4	91.5	92.9	92.6	92.6	92.3	91.8	91.3	90.6
-5	80.8	83.5	86.3	88.7	90.7	92.7	93.4	93.4	93.1	92.4	91.9	91.2
-10	80.0	82.7	85.5	87.9	89.9	91.9	93.6	94.3	94.0	93.2	92.6	91.8
-15	79.3	81.9	84.8	87.1	89.2	91.0	92.8	94.1	94.8	94.1	93.5	92.7
-20	78.5	81.1	83.9	86.4	88.4	90.2	91.9	93.2	94.4	94.5	93.9	93.1
-25	77.7	80.3	83.1	85.6	87.6	89.3	91.0	92.3	93.5	93.6	93.0	92.2
-30	76.9	79.5	82.2	84.7	86.8	88.5	90.1	91.4	92.6	92.7	92.1	91.3
-35	76.1	78.7	81.4	83.9	85.9	87.6	89.2	90.5	91.6	91.7	91.2	90.4
-40	75.3	77.8	80.5	83.0	85.1	86.7	88.3	89.6	90.7	90.8	90.3	89.5

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)											
	0	5	10	15	20	25	30	33	35	37	39	41
ENGINE ANTI-ICE	0.0	0.0	-1.0	-1.0	-1.1	-0.8	-1.0	-1.3	-1.8	-2.0	-2.0	-1.9
ENGINE & WING ANTI-ICE	0.0	0.0	-2.0	-2.0	-2.3	-2.1	-2.6	-3.2	-4.0	-4.1	-4.1	-4.0

ALTERNATE MODE EEC

Alternate Mode EEC Go-Around %N1

Based on engine bleed for packs on and anti-ice off

REPORTED OAT (°C)	TAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
		-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
59	60	85.5	86.0	86.4	86.5	86.6	86.6	86.6	86.6	86.6	86.7	86.4	86.1	85.7	84.8	83.8	82.7	81.6	81.0
54	55	87.0	87.4	87.8	87.8	87.9	87.9	87.9	87.9	87.9	88.0	87.7	87.4	87.0	86.1	85.2	84.0	82.9	82.3
49	50	88.5	88.9	89.2	89.2	89.2	89.2	89.1	89.2	89.2	89.2	89.0	88.6	88.3	87.4	86.4	85.3	84.2	83.6
44	45	89.8	90.3	90.7	90.7	90.6	90.6	90.5	90.4	90.4	90.5	90.2	89.9	89.5	88.6	87.7	86.6	85.5	84.9
39	40	91.1	91.6	92.1	92.1	92.0	92.0	91.9	91.8	91.7	91.6	91.4	91.1	90.7	89.8	88.9	87.8	86.7	86.1
34	35	92.4	92.9	93.4	93.4	93.4	93.3	93.1	92.9	92.7	92.4	92.2	92.0	91.8	90.9	90.0	89.0	87.9	87.4
29	30	91.7	93.0	94.3	94.5	94.5	94.3	94.1	93.9	93.6	93.3	93.0	92.8	92.6	91.8	91.0	90.1	89.1	88.7
24	25	90.9	92.2	93.5	94.0	94.6	95.1	95.0	94.8	94.5	94.2	93.9	93.7	93.5	92.7	91.9	91.1	90.2	89.8
19	20	90.1	91.4	92.7	93.1	93.7	94.3	94.8	95.2	95.3	95.0	94.6	94.4	94.3	93.6	92.8	92.0	91.2	90.8
14	15	89.3	90.5	91.8	92.3	92.9	93.5	94.0	94.3	94.7	95.1	95.6	95.6	95.2	94.2	93.3	92.7	91.9	91.5
9	10	88.5	89.7	91.0	91.5	92.1	92.6	93.1	93.5	93.8	94.2	94.8	95.5	96.1	95.7	94.6	93.5	92.5	92.2
4	5	87.6	88.9	90.2	90.7	91.3	91.8	92.3	92.7	93.0	93.4	93.9	94.7	95.3	95.1	95.0	94.9	94.1	93.6
-1	0	86.8	88.1	89.3	89.8	90.4	91.0	91.4	91.8	92.1	92.5	93.1	93.9	94.4	94.3	94.1	94.0	94.0	94.0
-6	-5	85.9	87.2	88.5	89.0	89.6	90.1	90.6	90.9	91.2	91.6	92.2	93.0	93.5	93.4	93.3	93.2	93.1	93.1
-11	-10	85.1	86.4	87.7	88.2	88.8	89.3	89.7	90.0	90.4	90.7	91.4	92.1	92.7	92.6	92.4	92.3	92.2	92.2
-16	-15	84.3	85.6	86.8	87.4	87.9	88.4	88.8	89.2	89.5	89.9	90.5	91.3	91.9	91.7	91.6	91.5	91.4	91.3
-21	-20	83.5	84.8	86.0	86.5	87.1	87.6	88.0	88.3	88.6	89.0	89.7	90.4	91.0	90.9	90.7	90.6	90.5	90.5
-26	-25	82.7	83.9	85.1	85.7	86.2	86.7	87.1	87.4	87.8	88.2	88.8	89.6	90.2	90.0	89.9	89.8	89.7	89.7
-31	-30	81.9	83.1	84.3	84.8	85.4	85.8	86.2	86.5	86.9	87.3	87.9	88.7	89.3	89.2	89.0	88.9	88.9	88.8
-36	-35	81.0	82.2	83.4	84.0	84.5	85.0	85.4	85.7	86.0	86.4	87.0	87.8	88.4	88.3	88.1	88.1	88.0	87.9
-41	-40	80.2	81.4	82.6	83.1	83.7	84.1	84.5	84.8	85.1	85.5	86.1	86.9	87.4	87.4	87.2	87.2	87.1	87.1
-46	-45	79.3	80.5	81.7	82.2	82.8	83.2	83.6	83.9	84.2	84.6	85.2	86.0	86.5	86.4	86.3	86.3	86.2	86.2
-51	-50	78.5	79.6	80.8	81.3	81.9	82.3	82.7	83.0	83.3	83.7	84.3	85.0	85.5	85.5	85.4	85.4	85.3	85.3

%N1 Adjustment forEngine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	14.5
PACKS OFF	0.7	0.8	0.8	0.9	1.0	0.9	1.0	1.0	1.1	1.2	1.4	1.4	1.6	1.8	2.0	2.0	2.0	2.1
A/C HIGH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ENGINE & WING ANTI-ICE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	-1.7	-1.9	-1.9	-2.0	-2.0	-2.0
ENGINE & WING ANTI-ICE*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.1	-2.5	-2.7	-2.9	-2.9	-2.9	-2.9

***Single Bleed Source**

ALTERNATE MODE EEC

ENGINE INOP

Alternate Mode EEC Initial Max Continuous %N1

Based on .79M, A/C high and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT)								
	25	27	29	31	33	35	37	39	41
20	88.8	88.5	88.2	88.7	88.6	89.0	89.2	88.6	88.0
15	89.9	89.5	89.1	89.6	89.5	89.0	88.5	87.9	87.2
10	91.0	90.5	90.1	90.5	90.3	89.9	89.0	88.4	87.7
5	91.4	91.4	91.0	91.3	91.2	90.8	90.1	89.6	89.0
0	90.6	91.6	91.8	92.2	92.0	91.6	90.9	90.2	89.4
-5	89.7	90.7	91.7	92.8	92.6	92.3	91.5	90.8	89.9
-10	88.8	89.7	90.8	92.4	93.3	93.1	92.3	91.5	90.6
-15	88.0	88.9	89.9	91.5	92.9	93.9	93.1	92.4	91.5
-20	87.2	88.1	89.1	90.7	92.0	93.3	93.3	92.6	91.7
-25	86.4	87.3	88.2	89.8	91.2	92.4	92.4	91.7	90.9
-30	85.6	86.4	87.4	89.0	90.3	91.5	91.4	90.8	90.0
-35	84.7	85.6	86.5	88.1	89.4	90.5	90.5	89.9	89.2
-40	83.9	84.7	85.6	87.2	88.5	89.6	89.5	89.0	88.3

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	25	27	29	31	33	35	37	39	41
ENGINE ANTI-ICE	-0.8	-0.8	-1.0	-1.0	-1.3	-1.8	-2.0	-2.0	-1.9
ENGINE & WING ANTI-ICE	-3.3	-3.5	-3.7	-4.1	-4.9	-6.1	-6.2	-6.2	-6.0

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Alternate Mode EEC Max Continuous %N1

Based on A/C high and anti-ice off

37000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
160	.51	87.9	88.9	89.9	90.8	91.8	91.8	91.9	91.9	91.5	90.5	90.2	90.8
200	.63	87.7	88.7	89.7	90.6	91.6	92.5	92.8	92.8	92.4	91.6	90.6	90.1
240	.74	87.1	88.1	89.1	90.1	91.0	92.0	92.9	93.5	93.1	92.1	91.3	90.7
280	.86	85.3	86.3	87.3	88.2	89.2	90.1	91.0	91.9	92.8	92.6	91.8	91.2

35000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-55	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0
160	.49	88.0	88.9	89.9	90.9	91.8	92.1	92.1	92.1	92.0	91.4	90.7	90.9
200	.60	87.2	88.1	89.1	90.0	91.0	91.9	92.3	92.3	92.3	92.3	91.4	90.7
240	.71	87.2	88.1	89.1	90.1	91.0	91.9	92.8	93.5	93.4	92.8	92.0	91.3
280	.82	86.1	87.0	88.0	88.9	89.8	90.8	91.7	92.6	93.4	93.2	92.4	91.7

33000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
160	.47	88.9	89.9	90.8	91.7	92.6	92.6	92.6	92.2	91.5	90.8	90.4	90.9
200	.58	88.5	89.4	90.3	91.3	92.2	93.1	93.1	92.6	92.1	91.6	90.9	90.2
240	.68	87.8	88.7	89.7	90.6	91.5	92.4	93.3	93.4	92.8	92.2	91.6	90.6
280	.79	86.7	87.6	88.5	89.4	90.3	91.2	92.1	92.9	93.3	92.6	92.0	91.2
320	.89	85.3	86.2	87.1	88.0	88.9	89.8	90.6	91.5	92.3	93.3	93.1	92.3

31000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
160	.45	88.7	89.6	90.5	91.5	92.4	92.9	92.9	92.5	91.7	90.9	90.3	90.0
200	.55	88.5	89.4	90.4	91.3	92.2	93.1	93.6	93.2	92.3	91.6	91.0	90.1
240	.66	87.6	88.6	89.5	90.4	91.3	92.2	93.1	93.7	93.1	92.2	91.6	90.7
280	.76	86.1	87.0	87.9	88.8	89.6	90.5	91.4	92.2	93.1	92.7	92.1	91.2
320	.85	84.0	85.0	85.9	86.7	87.6	88.4	89.3	90.1	90.9	91.9	92.4	91.7

29000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
160	.43	89.0	89.9	90.8	91.7	92.6	92.9	92.3	91.3	90.5	89.8	88.9	89.0
200	.53	88.6	89.6	90.5	91.4	92.3	93.2	93.1	92.2	91.3	90.5	89.4	88.5
240	.63	87.9	88.9	89.8	90.7	91.6	92.4	93.3	92.9	92.0	91.1	90.1	89.0
280	.73	86.1	87.0	87.9	88.8	89.6	90.5	91.3	92.2	92.4	91.6	90.7	89.7
320	.82	84.0	84.9	85.8	86.6	87.5	88.3	89.1	90.0	90.9	91.8	91.1	90.3
360	.91	83.5	84.4	85.3	86.2	87.0	87.8	88.7	89.5	90.4	91.3	91.9	92.0

ALTERNATE MODE EEC
ENGINE INOP
MAX CONTINUOUS THRUST

Max Continuous %N1
%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	37	35	33	31	29
ENGINE ANTI-ICE	-2.0	-1.8	-1.3	-1.0	-1.0
ENGINE & WING ANTI-ICE	-6.1	-5.9	-4.8	-3.9	-3.6

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

27000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
160	.41	89.0	89.9	90.8	91.8	92.7	93.5	93.1	91.8	90.9	90.3	89.2	88.2
200	.51	88.2	89.1	90.0	90.9	91.8	92.7	93.3	92.5	91.7	91.0	89.8	88.7
240	.60	87.4	88.3	89.2	90.1	91.0	91.9	92.7	93.4	92.4	91.6	90.6	89.5
280	.70	85.7	86.6	87.5	88.4	89.2	90.1	90.9	91.7	92.7	92.1	91.1	90.0
320	.79	83.8	84.7	85.6	86.4	87.2	88.1	88.9	89.7	90.7	91.6	91.4	90.5
360	.88	82.6	83.5	84.4	85.2	86.1	86.9	87.7	88.5	89.4	90.4	91.1	91.6

25000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
160	.39	90.1	91.0	91.9	92.7	93.6	93.7	92.4	91.4	90.7	89.7	88.5	88.0
200	.49	88.9	89.8	90.7	91.6	92.5	93.3	93.1	92.1	91.3	90.3	89.1	88.0
240	.58	87.7	88.6	89.4	90.3	91.1	92.0	92.8	92.8	91.9	90.9	89.8	88.6
280	.67	86.2	87.0	87.9	88.8	89.6	90.4	91.2	92.2	92.4	91.5	90.4	89.2
320	.76	84.4	85.3	86.1	87.0	87.8	88.6	89.4	90.3	91.2	91.8	90.8	89.7
360	.85	82.6	83.4	84.3	85.1	85.9	86.7	87.5	88.3	89.2	90.0	90.7	90.2

24000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
160	.38	90.0	90.9	91.8	92.7	93.6	94.5	93.1	92.0	91.2	90.2	89.1	88.1
200	.48	89.9	90.8	91.7	92.6	93.5	94.4	94.7	93.2	92.2	91.3	90.1	89.1
240	.57	89.4	90.3	91.2	92.1	93.0	93.9	94.7	94.9	93.2	92.2	91.1	90.0
280	.66	87.2	88.1	89.0	89.9	90.7	91.6	92.4	93.3	93.8	92.7	91.7	90.6
320	.75	85.3	86.2	87.1	87.9	88.8	89.6	90.4	91.2	92.1	92.9	92.1	91.1
360	.83	83.5	84.4	85.2	86.1	86.9	87.7	88.5	89.3	90.1	90.9	91.7	91.6

22000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
160	.37	89.9	90.8	91.7	92.5	93.4	93.6	92.3	91.4	90.4	89.3	88.2	87.6
200	.46	89.5	90.4	91.3	92.2	93.0	93.9	93.5	92.4	91.4	90.3	89.2	88.1
240	.55	91.6	92.5	93.4	94.3	95.2	96.1	97.0	95.8	94.2	93.1	92.0	90.9
280	.63	89.5	90.5	91.3	92.2	93.1	94.0	94.8	95.7	95.0	93.6	92.5	91.5
320	.72	87.2	88.1	89.0	89.9	90.7	91.6	92.4	93.2	94.0	94.0	93.0	92.0
360	.80	85.3	86.2	87.1	87.9	88.7	89.6	90.4	91.2	92.0	92.8	93.3	92.4

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

20000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
160	.35	89.2	90.0	90.8	91.7	92.5	93.4	92.8	91.8	90.7	89.5	88.3	87.2
200	.44	88.4	89.3	90.1	90.9	91.7	92.6	93.4	92.4	91.3	90.1	88.9	87.8
240	.53	91.5	92.4	93.2	94.1	94.9	95.8	96.7	97.4	96.1	94.9	93.7	92.6
280	.61	90.8	91.7	92.6	93.4	94.3	95.1	95.9	96.8	97.5	96.0	94.7	93.7
320	.69	88.9	89.8	90.7	91.5	92.3	93.1	93.9	94.7	95.5	96.4	95.2	94.2
360	.77	86.7	87.6	88.5	89.3	90.1	90.9	91.6	92.4	93.2	94.0	94.8	94.4

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	27	25	24	22	20
ENGINE ANTI-ICE	-0.8	-0.8	-0.9	-1.0	-1.1
ENGINE & WING ANTI-ICE	-3.4	-3.3	-3.1	-3.5	-3.5

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

18000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
160	.34	88.5	89.3	90.1	90.9	91.8	92.7	92.1	91.1	89.9	88.7	87.5	86.2
200	.42	87.7	88.5	89.4	90.2	91.0	91.8	92.3	91.7	90.4	89.2	88.1	87.1
240	.51	90.4	91.3	92.1	93.0	93.8	94.7	95.5	95.8	94.9	93.7	92.6	91.6
280	.59	92.2	93.1	93.9	94.8	95.6	96.5	97.3	98.2	97.8	96.2	95.1	94.1
320	.67	90.2	91.1	92.0	92.8	93.6	94.4	95.2	96.1	96.9	96.7	95.5	94.6
360	.75	88.0	88.9	89.7	90.5	91.3	92.1	92.9	93.7	94.5	95.3	95.7	94.9

16000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
160	.33	87.6	88.5	89.3	90.1	90.9	91.8	92.3	91.4	90.2	89.0	87.9	86.7
200	.41	87.2	88.0	88.9	89.7	90.5	91.3	92.1	91.9	90.8	89.6	88.4	87.3
240	.49	88.1	88.9	89.8	90.6	91.4	92.2	93.1	93.9	93.8	92.8	91.6	90.6
280	.57	92.0	92.9	93.8	94.6	95.5	96.3	97.1	98.0	98.9	97.4	96.1	95.2
320	.64	90.3	91.2	92.0	92.9	93.7	94.5	95.4	96.2	97.0	97.9	96.5	95.6
360	.72	87.7	88.6	89.5	90.3	91.1	91.9	92.7	93.5	94.2	95.1	95.9	95.5

14000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
160	.31	88.3	89.1	89.9	90.7	91.6	92.4	92.4	91.4	90.2	89.1	88.0	87.2
200	.39	87.9	88.7	89.6	90.4	91.2	92.0	92.8	91.9	90.7	89.6	88.6	87.5
240	.47	87.5	88.4	89.2	90.0	90.8	91.6	92.4	93.2	92.6	91.5	90.4	89.4
280	.54	91.6	92.5	93.4	94.2	95.0	95.9	96.7	97.5	97.7	96.4	95.4	94.5
320	.62	90.4	91.4	92.2	93.0	93.9	94.7	95.5	96.3	97.1	97.2	96.0	95.2
360	.69	87.6	88.4	89.3	90.1	90.9	91.7	92.5	93.2	94.0	94.8	95.2	94.7

12000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	35
160	.30	89.5	90.3	91.2	92.0	92.8	93.7	93.3	92.2	91.2	90.2	89.2	88.2
200	.38	89.1	89.9	90.7	91.5	92.3	93.2	93.7	92.8	91.6	90.7	89.6	88.6
240	.45	88.1	88.9	89.8	90.6	91.3	92.2	93.0	93.0	92.2	91.2	90.2	89.2
280	.52	91.0	91.9	92.7	93.5	94.4	95.2	96.0	96.9	96.4	95.5	94.5	93.6
320	.60	90.1	91.0	91.9	92.7	93.5	94.3	95.1	96.0	96.8	96.1	95.1	94.2
360	.67	86.5	87.4	88.2	89.0	89.8	90.5	91.3	92.1	92.9	93.6	93.8	93.5

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	18	16	14	12
ENGINE ANTI-ICE	-1.2	-1.2	-1.0	-1.1
ENGINE & WING ANTI-ICE	-3.7	-3.3	-3.0	-3.0

ALTERNATE MODE EEC

ENGINE INOP

MAX CONTINUOUS THRUST

Max Continuous %N1

Based on A/C high and anti-ice off

10000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-20	-15	-10	-5	0	5	10	15	20	25	30	35
160	.29	89.8	90.7	91.5	92.3	93.2	94.0	94.8	94.2	93.2	92.3	91.3	90.4
200	.36	89.3	90.1	90.9	91.8	92.6	93.4	94.2	94.4	93.7	92.7	91.7	90.8
240	.43	88.6	89.5	90.3	91.1	91.9	92.8	93.6	94.4	94.1	93.2	92.2	91.2
280	.51	90.3	91.1	92.0	92.8	93.6	94.5	95.3	96.1	96.7	95.7	94.7	93.8
320	.58	88.8	89.7	90.5	91.3	92.1	92.9	93.7	94.5	95.4	95.8	95.1	94.2
360	.65	84.7	85.5	86.3	87.1	87.9	88.7	89.4	90.2	90.9	91.7	92.2	92.2

5000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-10	-5	0	5	10	15	20	25	30	35	40	45
160	.26	89.3	90.2	91.0	91.9	92.7	93.6	94.1	93.2	92.3	91.3	90.3	89.4
200	.33	89.0	89.9	90.7	91.6	92.4	93.3	94.1	93.6	92.6	91.7	90.7	89.7
240	.40	88.5	89.3	90.2	91.0	91.9	92.7	93.5	94.0	93.1	92.2	91.2	90.2
280	.46	87.9	88.7	89.6	90.4	91.2	92.1	92.9	93.7	93.7	92.8	91.9	90.9
320	.53	86.0	86.8	87.6	88.4	89.3	90.1	90.9	91.6	92.4	92.5	92.2	91.7
360	.59	81.5	82.3	83.1	83.8	84.6	85.4	86.1	86.9	87.6	88.4	88.4	88.4

3000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-5	0	5	10	15	20	25	30	35	40	45	50
160	.26	89.0	89.8	90.6	91.4	92.3	93.1	93.2	92.3	91.4	90.4	89.4	88.5
200	.32	88.6	89.4	90.3	91.1	91.9	92.7	93.6	92.7	91.7	90.7	89.7	88.8
240	.38	88.1	88.9	89.7	90.6	91.4	92.2	93.0	93.0	92.2	91.2	90.2	89.3
280	.45	87.5	88.3	89.1	89.9	90.7	91.5	92.3	93.1	92.5	91.6	90.6	89.8
320	.51	84.7	85.5	86.3	87.1	87.9	88.6	89.4	90.2	90.9	90.9	90.8	90.5
360	.57	80.5	81.3	82.0	82.7	83.5	84.2	84.9	85.7	86.4	86.9	86.9	86.9

1000 FT Pressure Altitude

		TAT (°C)											
KIAS	M	-5	0	5	10	15	20	25	30	35	40	45	50
160	.25	87.7	88.6	89.4	90.2	91.0	91.8	92.6	92.3	91.4	90.5	89.5	88.6
200	.31	87.4	88.2	89.0	89.8	90.6	91.5	92.3	92.6	91.7	90.7	89.8	88.8
240	.37	86.9	87.7	88.5	89.3	90.1	90.9	91.7	92.5	92.1	91.2	90.2	89.2
280	.43	85.2	86.0	86.8	87.6	88.4	89.2	89.9	90.7	91.3	91.0	90.4	89.7
320	.49	82.6	83.4	84.2	84.9	85.7	86.4	87.2	88.0	88.7	89.1	89.0	89.0
360	.55	78.8	79.5	80.3	81.0	81.7	82.5	83.2	83.9	84.6	85.3	85.5	85.5

Max Continuous %N1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	10	5	3	1
ENGINE ANTI-ICE	-1.1	0.0	0.0	0.0
ENGINE & WING ANTI-ICE	-2.8	0.0	0.0	0.0

Intentionally
Blank

Performance Inflight — Chapter PI
Gear Down — Section 36

GEAR DOWN

Long Range Cruise Altitude Capability
Max Cruise Thrust, 100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
85	18300	16100	13400
80	20500	18400	15900
75	22600	20800	18600
70	24900	23300	21300
65	27000	25700	24200
60	29100	27900	26700
55	31300	30400	29100
50	33300	32700	32100
45	35600	34900	34500
40	38000	37500	37000

GEAR DOWN

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)									
		10	21	23	25	27	29	31	33	35	37
85	%N1	79.7									
	MACH	.466									
	KIAS	258									
	FF/ENG	1909									
80	%N1	77.8	88.0								
	MACH	.453	.559								
	KIAS	250	251								
	FF/ENG	1789	1834								
75	%N1	75.7	86.0	88.1							
	MACH	.439	.541	.564							
	KIAS	242	242	243							
	FF/ENG	1666	1699	1720							
70	%N1	73.6	83.9	85.9	88.1						
	MACH	.424	.524	.546	.568						
	KIAS	234	234	234	235						
	FF/ENG	1547	1572	1588	1606						
65	%N1	71.3	81.8	83.7	85.7	87.8					
	MACH	.408	.506	.526	.549	.572					
	KIAS	225	226	226	226	226					
	FF/ENG	1431	1452	1458	1474	1491					
60	%N1	68.9	79.6	81.4	83.3	85.4	87.5				
	MACH	.393	.488	.507	.528	.551	.574				
	KIAS	217	218	217	217	218	217				
	FF/ENG	1323	1335	1337	1343	1359	1375				
55	%N1	66.4	77.1	79.0	80.8	82.7	84.9	87.1			
	MACH	.376	.468	.487	.507	.528	.552	.574			
	KIAS	208	209	209	208	208	209	208			
	FF/ENG	1221	1221	1222	1223	1228	1243	1259			
50	%N1	63.9	74.3	76.3	78.2	80.1	82.0	84.2	86.3		
	MACH	.360	.447	.466	.485	.505	.527	.551	.574		
	KIAS	199	199	199	199	199	199	199	199		
	FF/ENG	1121	1105	1108	1109	1108	1112	1127	1144		
45	%N1	61.2	71.1	73.2	75.2	77.2	79.1	81.0	83.2	85.4	
	MACH	.345	.424	.443	.462	.481	.502	.523	.547	.572	
	KIAS	190	189	189	189	189	189	189	189	189	
	FF/ENG	1023	997	993	996	996	994	998	1011	1028	
40	%N1	58.2	67.6	69.7	71.7	73.9	75.9	77.8	79.7	81.8	84.5
	MACH	.328	.400	.418	.436	.456	.475	.496	.517	.541	.567
	KIAS	181	178	178	178	179	179	178	178	178	179
	FF/ENG	927	899	887	881	891	886	883	886	895	921

GEAR DOWN

Long Range Cruise Enroute Fuel and Time

Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
331	294	263	238	218	200	188	178	168	160	153
670	594	528	477	436	400	377	357	338	321	306
1012	896	796	718	655	600	566	534	506	481	459
1359	1200	1065	959	874	800	754	712	675	641	612
1711	1508	1336	1202	1094	1000	943	890	843	801	764
2066	1819	1609	1446	1314	1200	1131	1067	1010	960	915
2427	2133	1883	1690	1534	1400	1318	1244	1178	1118	1066
2792	2449	2159	1934	1755	1600	1507	1421	1345	1276	1216
3162	2769	2437	2180	1976	1800	1694	1598	1511	1434	1366
3538	3093	2716	2427	2198	2000	1882	1774	1677	1591	1515
3919	3420	2999	2676	2420	2200	2069	1950	1843	1748	1664

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		20		24		28	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	2.0	0:51	1.8	0:48	1.6	0:45	1.4	0:43	1.3	0:41
400	4.0	1:40	3.7	1:34	3.3	1:27	3.1	1:22	2.9	1:18
600	6.1	2:30	5.6	2:21	5.1	2:09	4.8	2:02	4.5	1:55
800	8.1	3:20	7.5	3:09	6.8	2:52	6.4	2:42	6.0	2:33
1000	10.0	4:12	9.3	3:57	8.5	3:35	8.0	3:23	7.5	3:11
1200	12.0	5:05	11.1	4:46	10.1	4:20	9.5	4:04	9.0	3:49
1400	13.9	5:58	12.9	5:37	11.8	5:05	11.1	4:46	10.5	4:28
1600	15.7	6:53	14.7	6:28	13.4	5:51	12.6	5:28	11.9	5:08
1800	17.6	7:48	16.4	7:20	15.0	6:37	14.1	6:12	13.3	5:48
2000	19.4	8:44	18.1	8:13	16.5	7:25	15.5	6:55	14.7	6:29
2200	21.1	9:42	19.8	9:07	18.1	8:13	17.0	7:40	16.0	7:10

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	40	50	60	70	80
2	-0.3	-0.1	0.0	0.2	0.6
4	-0.6	-0.3	0.0	0.5	1.2
6	-0.9	-0.5	0.0	0.7	1.7
8	-1.3	-0.6	0.0	0.9	2.2
10	-1.6	-0.8	0.0	1.2	2.7
12	-1.9	-1.0	0.0	1.4	3.2
14	-2.2	-1.1	0.0	1.6	3.6
16	-2.5	-1.3	0.0	1.8	4.0
18	-2.8	-1.4	0.0	2.0	4.4
20	-3.2	-1.6	0.0	2.2	4.7
22	-3.5	-1.8	0.0	2.4	5.1

GEAR DOWN

Descent

VREF40+70 KIAS

PRESSURE ALTITUDE (FT)	TIME (MIN)	FUEL (KG)	DISTANCE (NM)
41000	20.8	220	92
39000	20.1	215	87
37000	19.3	210	82
35000	18.6	205	78
33000	17.9	200	73
31000	17.2	195	69
29000	16.4	190	65
27000	15.6	185	60
25000	14.8	179	56
23000	14	173	52
21000	13.2	167	48
19000	12.3	160	44
17000	11.5	153	40
15000	10.6	146	36
10000	8.3	126	26
5000	5.8	103	16
1500	4	84	10

Allowances for a straight-in approach are included.

GEAR DOWN

Holding

Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)							
		1500	5000	10000	15000	20000	25000	30000	35000
85	%N1	69.2	72.3	77.1	82.0	86.9			
	KIAS	233	233	233	233	234			
	FF/ENG	1820	1810	1820	1850	1890			
80	%N1	67.5	70.4	75.2	80.1	85.0			
	KIAS	226	226	226	226	227			
	FF/ENG	1710	1700	1710	1730	1760			
75	%N1	65.7	68.5	73.2	78.1	83.0	88.5		
	KIAS	219	219	219	219	219	221		
	FF/ENG	1600	1600	1590	1610	1630	1690		
70	%N1	63.8	66.6	71.1	76.0	81.0	86.1		
	KIAS	214	214	214	214	214	214		
	FF/ENG	1500	1490	1490	1500	1520	1550		
65	%N1	62.0	64.8	69.1	74.0	78.9	83.9		
	KIAS	210	210	210	210	210	210		
	FF/ENG	1410	1400	1400	1400	1410	1430		
60	%N1	60.1	62.8	67.0	71.8	76.8	81.6	87.1	
	KIAS	204	204	204	204	204	204	204	
	FF/ENG	1320	1310	1310	1300	1300	1320	1360	
55	%N1	58.0	60.6	64.9	69.5	74.4	79.4	84.5	
	KIAS	198	198	198	198	198	198	198	
	FF/ENG	1240	1220	1220	1200	1200	1210	1230	
50	%N1	55.9	58.4	62.6	67.1	71.9	77.0	81.9	
	KIAS	191	191	191	191	191	191	191	
	FF/ENG	1150	1140	1130	1110	1110	1110	1120	
45	%N1	53.8	56.2	60.2	64.6	69.3	74.4	79.4	84.6
	KIAS	185	185	185	185	185	185	185	185
	FF/ENG	1060	1060	1040	1040	1030	1010	1020	1050
40	%N1	51.6	53.8	57.6	62.0	66.6	71.6	76.7	81.7
	KIAS	178	178	178	178	178	178	178	178
	FF/ENG	980	970	950	950	950	920	920	930

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

Performance Inflight — Chapter PI
Gear Down, Engine Inop — Section 37

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

100 ft/min residual rate of climb

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFTDOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
85	81	231	2500		
80	77	225	5200	3100	
75	72	219	7400	5800	3800
70	67	214	9500	8100	6300
65	63	210	11200	10200	8800
60	58	204	12900	11800	10700
55	53	198	14600	13400	12300
50	48	192	17300	15500	14000
45	43	185	20100	18600	16700
40	38	178	22700	21500	20100

Includes APU fuel burn.

GEAR DOWN

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability

100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
75	2600		
70	5900	3700	
65	8500	6800	4700
60	10800	9700	7900
55	12800	11700	10600
50	14900	13700	12600
45	18400	16600	14700
40	21800	20600	19000

GEAR DOWN
ENGINE INOP
MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT) 5	7	9	11	13	15	17	19	21
70	%N1	89.7	91.8							
	MACH	.386	.400							
	KIAS	233	234							
	FF/ENG	3176	3210							
65	%N1	87.2	89.2	91.3						
	MACH	.372	.386	.401						
	KIAS	225	225	225						
	FF/ENG	2923	2942	2973						
60	%N1	84.8	86.6	88.5	90.7					
	MACH	.359	.371	.385	.400					
	KIAS	217	217	217	217					
	FF/ENG	2689	2691	2707	2735					
55	%N1	82.3	84.0	85.8	87.7	89.8				
	MACH	.346	.357	.370	.383	.399				
	KIAS	210	208	208	208	208				
	FF/ENG	2470	2460	2460	2473	2497				
50	%N1	79.4	81.3	83.0	84.7	86.6	88.7			
	MACH	.333	.344	.355	.367	.380	.396			
	KIAS	201	200	199	198	198	198			
	FF/ENG	2256	2245	2233	2230	2240	2258			
45	%N1	76.1	78.1	79.9	81.7	83.4	85.2	87.4	89.7	
	MACH	.318	.328	.339	.351	.362	.376	.391	.407	
	KIAS	192	191	191	190	189	188	188	188	
	FF/ENG	2037	2031	2021	2009	2004	2008	2021	2046	
40	%N1	72.5	74.4	76.3	78.2	80.0	81.8	83.6	85.6	87.9
	MACH	.302	.312	.322	.334	.345	.357	.369	.384	.400
	KIAS	182	182	181	180	179	178	178	178	178
	FF/ENG	1820	1813	1808	1800	1790	1781	1778	1786	1804

Includes APU fuel burn.

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
168	149	132	119	109	100	93	88	83	78	75
343	302	267	240	219	200	187	174	164	155	147
518	455	402	361	328	300	280	261	245	231	219
695	610	538	483	438	400	373	348	327	308	292
873	765	674	604	548	500	466	435	408	384	363
1053	922	812	726	659	600	558	521	488	459	435
1233	1079	948	848	769	700	651	608	569	536	507
1415	1237	1086	970	879	800	744	694	650	611	578
1597	1395	1224	1093	989	900	837	780	730	687	650
1782	1555	1363	1216	1100	1000	929	866	810	762	721

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)					
	6		10		14	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
100	1.0	0:27	0.9	0:26	0.8	0:25
200	2.2	0:53	2.0	0:51	1.9	0:48
300	3.3	1:19	3.0	1:15	2.9	1:11
400	4.4	1:45	4.1	1:40	3.9	1:34
500	5.5	2:11	5.1	2:05	4.9	1:58
600	6.5	2:38	6.2	2:30	5.9	2:21
700	7.6	3:04	7.2	2:55	6.9	2:45
800	8.6	3:31	8.2	3:21	7.8	3:09
900	9.7	3:59	9.1	3:46	8.8	3:33
1000	10.7	4:26	10.1	4:12	9.7	3:58

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	40	50	60	70	80
1	-0.2	-0.1	0.0	0.2	0.4
2	-0.4	-0.2	0.0	0.4	1.0
3	-0.6	-0.3	0.0	0.6	1.5
4	-0.7	-0.4	0.0	0.8	1.9
5	-0.9	-0.5	0.0	1.0	2.4
6	-1.1	-0.5	0.0	1.2	2.8
7	-1.3	-0.6	0.0	1.4	3.2
8	-1.5	-0.7	0.0	1.5	3.5
9	-1.7	-0.8	0.0	1.7	3.9
10	-1.9	-0.9	0.0	1.8	4.2
11	-2.1	-1.0	0.0	1.9	4.5

Includes APU fuel burn.

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
85	%N1	89.9				
	KIAS	233				
	FF/ENG	3730				
80	%N1	87.8	91.5			
	KIAS	226	226			
	FF/ENG	3480	3530			
75	%N1	85.7	89.2			
	KIAS	219	219			
	FF/ENG	3240	3270			
70	%N1	83.5	87.0			
	KIAS	214	214			
	FF/ENG	3000	3030			
65	%N1	81.4	84.8	89.9		
	KIAS	210	210	210		
	FF/ENG	2810	2820	2880		
60	%N1	79.1	82.5	87.4		
	KIAS	204	204	204		
	FF/ENG	2600	2610	2650		
55	%N1	76.5	80.0	85.0		
	KIAS	198	198	198		
	FF/ENG	2400	2410	2430		
50	%N1	73.9	77.3	82.4	87.3	
	KIAS	191	191	191	191	
	FF/ENG	2210	2220	2230	2260	
45	%N1	71.1	74.4	79.6	84.5	90.2
	KIAS	185	185	185	185	185
	FF/ENG	2030	2030	2040	2060	2110
40	%N1	68.3	71.4	76.5	81.6	86.7
	KIAS	178	178	178	178	178
	FF/ENG	1860	1850	1850	1860	1880

This table includes 5% additional fuel for holding in a racetrack pattern.
Includes APU fuel burn.

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Performance Inflight — Chapter PI
Text — Section 38

Introduction

This chapter contains information to supplement performance data from the Flight Management Computer (FMC). In addition, sufficient inflight data is provided to complete a flight with the FMC inoperative. In the event of conflict between data presented in this chapter and that contained in the approved Airplane Flight Manual, the Flight Manual shall always take precedence.

General

Takeoff Speeds

The speeds presented in the Takeoff Speeds table, as well as FMC computed takeoff speeds, can be used for all performance conditions except where adjustments must be made for anti-skid inoperative, thrust reversers inoperative, improved climb, contaminated runway situations, or brake energy limits.

V1 adjustments are not necessary for equal amounts of clearway and stopway. V1 for takeoff limit weights based on unequal clearway and stopway should be obtained from computerized takeoff speed calculations for the specific takeoff conditions.

These speeds may be used for weights less than or equal to the performance limited weight subject to the restrictions noted above.

The FMC will protect minimum control speeds by increasing V1, VR, and V2 as required. However, the FMC will not compute takeoff speeds for weights where the required speed increase exceeds the maximum certified speed increase. This typically occurs at full rated thrust and light weights. In this case, the message "V SPEEDS UNAVAILABLE" will appear on the FMC scratchpad and the takeoff speed entries will be blank. In this situation, manually verify takeoff speeds using an approved source of takeoff performance information. Upon verifying takeoff speeds, takeoff is permitted. When the selected takeoff speeds cannot be verified, the options are to select a lower flap setting, select derate thrust and/or increase airplane gross weight (e.g. add fuel). Selecting derate thrust is the preferred method as this will reduce the minimum control speeds. Note that the assumed temperature method will not help this condition as the minimum control speeds are determined at the actual temperature and therefore are not reduced by an assumed temperature selection.

Takeoff speeds are determined as follows:

1. Determine V1, VR, and V2 from the Takeoff Speeds table (Table 1) with brake release weight.
2. Adjust V1, VR, and V2 for temperature and pressure altitude from the V1, VR, V2 Adjustments table (Table 2).
3. Adjust V1 for wind and slope from the Slope and Wind V1 Adjustments table (Table 3).
4. Determine V1(MCG) from the V1(MCG) table (Table 4).
5. If V1 from Step 3 is less than V1(MCG), set V1=V1(MCG).
6. If the VR from Step 2 is less than V1(MCG), set VR equal to V1(MCG) and determine a new V2 by adding the difference between the VR from Step 2 and V1(MCG) to the normal V2.

Note: Regulations prohibit scheduling takeoff with a V1 less than minimum V1 for control on the ground, V1(MCG). It is therefore necessary to compare the adjusted V1 to V1(MCG). The V1(MCG) presented in this manual is conservative for all weight and bleed configurations. No takeoff weight adjustment is necessary provided that the actual field length exceeds the minimum field length shown in the Field and Climb Limit Weight table in the chapter Performance Dispatch.

Stabilizer Trim Setting

To find takeoff stabilizer trim setting, enter the Stabilizer Trim Setting table with anticipated brake release weight and center of gravity (C.G. % MAC) and read required stabilizer trim units.

VREF

This table contains flaps 40, 30 and 15 reference speeds for a given weight for a reference pressure altitude of 14500 feet. These data are consistent with the FMC. The FMC uses a reference pressure altitude of 14500 feet to calculate VREF when the origin or destination airports have not been defined. For similar conditions, VREF values at 14500 feet are conservative for lower pressure altitudes.

Flap Maneuver Speeds

This table provides flap maneuver speeds for various flap settings. During flap retraction, selection of the next flap position is initiated when reaching the maneuver speed for the existing flap position. During flap retraction, at least adequate maneuver capability of 30° of bank (15° of bank and 15° overshoot) to stick shaker is provided at the flap retraction speed. Full maneuvering capability of at least 40° of bank (25° of bank and 15° overshoot) is provided when the airplane has accelerated to the recommended maneuver speed for the selected flap position.

During flap extension, selection of the flaps to the next flap position should be made when approaching, and before decelerating below, the maneuver speed for the existing flap position. The flap extension speed schedule varies with airplane weight and provides full maneuver capability of at least 40° of bank (25° of bank and 15° overshoot) to stick shaker at all weights.

Slush/Standing Water Takeoff

Experience has shown that aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water or ice. Therefore, reductions in runway/obstacle limited takeoff weight and revised takeoff speeds are necessary. The tables are intended for guidance in accordance with advisory material and assume an engine failure at the critical point during the takeoff.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore this information is conservative when operating under typical colder weather conditions where patches of slush exist and some degree of sanding is common. Takeoffs in slush depths greater than 0.5 inches (13 mm) are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

Takeoff weight is determined as follows:

1. Determine the dry field/obstacle limit weight for the takeoff flap setting.
2. Enter the Weight Adjustment table (Table 1) with the dry field/obstacle limit weight to obtain the weight reduction for the slush/standing water depth and airport pressure altitude.
3. Adjust field length available for temperature by the amount provided in the notes below the V1(MCG) Limit Weight table (Table 2).

4. Enter the V1(MCG) Limit Weight table (Table 2) with the adjusted field length and pressure altitude to obtain the slush/standing water limit weight with respect to minimum field length required for V1(MCG) speed.
5. The maximum allowable takeoff weight in slush/standing water is the lesser of the limit weights found in steps 2 and 4.

Takeoff speed determination:

1. Determine takeoff speeds V1, VR and V2 for actual brake release weight using the Dry Runway Takeoff Speeds tables in this section.
2. If V1(MCG) limited, set V1=V1(MCG). If not limited by V1(MCG) considerations, enter the V1 Adjustment table (Table 3) with actual brake release weight to determine the V1 reduction to apply to V1 speed. If the adjusted V1 is less than V1(MCG), set V1=V1(MCG).

Dry Snow Runway Takeoff

In addition to slush/standing water, the data are provided for dry snow covered runways. Takeoff in dry snow depths greater than 4.0 inches (100 mm) is not recommended. The tables provided are used in the same manner as the Slush/Standing Water Takeoff tables.

Wet Snow Runway Takeoff

In addition to slush/standing water and dry snow, data are provided for wet snow covered runways. The tables provided are used in the same manner as the Slush/Standing Water Takeoff tables.

Slippery Runway Takeoff

Airplane braking action is reported as good, medium or poor, depending on existing runway conditions. If braking action is reported as good, conditions should not be expected to be as good as on clean, dry runways. The value “good” is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when stopping. The performance level of good is the same as used by the FAA and EASA to define wet runway rejected takeoff performance. A braking action of good to medium (interpolation between good and medium) is representative of a runway covered with compacted snow. Similarly, poor braking action is representative of a runway covered with ice. Performance is based on reversers operating and a 15 ft screen height at the end of the runway. The tables provided are used in the same manner as the Slush/Standing Water tables.

One Thrust Reverser Inoperative

Wet runway takeoff performance presented for all brakes operating is based on the use of one thrust reverser during deceleration. When operating with a thrust reverser inoperative, the runway/obstacle limited takeoff weight and V1 speed must be reduced to account for the reduced deceleration capability.

A simplified method which conservatively accounts for this is to reduce the normal wet runway/obstacle limited weight by 1250 kg and the V1 associated with the reduced weight by two knots.

If the resulting V1 is less than V1(MCG), takeoff is permitted with V1 set equal to V1(MCG) provided the accelerate stop distance available corrected for wind and slope exceeds approximately 1500 m.

Anti-Skid Inoperative

When operating with anti-skid inoperative, the field limit weight and V1 must be reduced to account for the effect on accelerate-stop performance. Anti-skid inoperative is only allowed on a dry runway. A simplified method which conservatively accounts for the effects of anti-skid inoperative is to reduce the normal dry field/obstacle limited weight by 8950 kg and the V1 associated with the reduced weight by the amount shown in the table below.

ANTI-SKID INOPERATIVE V1 ADJUSTMENTS	
FIELD LENGTH (M)	V1 ADJUSTMENT (KIAS)
2000	-23
2500	-20
3000	-17
3500	-15
4000	-13

If the resulting V1 is less than V1(MCG), takeoff is permitted with V1 set equal to V1(MCG) provided the dry accelerate-stop distance available adjusted for wind and slope exceeds approximately 2150 m.

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Takeoff %N1

To find Max Takeoff %N1 based on normal engine bleed for air conditioning packs on, enter Takeoff %N1 Table with airport pressure altitude and airport OAT and read %N1. Apply %N1 adjustments as provided when applicable.

Assumed Temperature Reduced Thrust

Regulations permit the use of up to 25% takeoff thrust reduction for operation with assumed temperature reduced thrust. Use of assumed temperature reduced thrust is not allowed with anti-skid inoperative or on runways contaminated with standing water, ice, slush, or snow. Use of assumed temperature reduced thrust is not recommended if potential windshear conditions exist.

To find the maximum allowable assumed temperature enter the Maximum Assumed Temperature table with airport pressure altitude and OAT. Compare this temperature to that at which the airplane is performance limited as determined from available takeoff performance data. Next, enter the Maximum Takeoff %N1 table with airport pressure altitude and the lower of the two temperatures previously determined, to obtain a maximum takeoff %N1. Do not use an assumed temperature less than the minimum assumed temperature shown. Enter the %N1 Adjustment table with OAT and the difference between the assumed and actual OAT to obtain a %N1 adjustment. Subtract the %N1 adjustment from the maximum takeoff %N1 found previously to determine the assumed temperature reduced thrust %N1.

Apply %N1 adjustments as provided when applicable.

Max Climb %N1

This table shows Max Climb %N1 for a 280/.78 climb speed schedule. Enter the table with airport pressure altitude and TAT and read %N1. Apply %N1 adjustments as provided when applicable.

Go-Around %N1

To find Go-Around %N1, enter the Go-Around %N1 table with airport pressure altitude and reported OAT or TAT and read %N1. Apply %N1 adjustments as provided when applicable.

Flight with Unreliable Airspeed/ Turbulent Air Penetration

Information is provided for use in all phases of flight in the event of unreliable airspeed/Mach indications resulting from blocking or freezing of the pitot system. Loss of radome or turbulent air may also cause unreliable airspeed/Mach indications. The cruise table in this section may also be used for turbulent air penetration. These speeds provide ample protection from stall and high speed buffet, while also providing protection from exceeding the structural limits. For climb, cruise, and descent these tables are based on a speed schedule of 280 KIAS below crossover altitude and .76 Mach above crossover altitude.

Pitch attitude and power setting are shown in bold type to emphasize pilot action. Altitude and/or vertical speed indications may also be unreliable. The pitch attitude is provided to the nearest half degree.

Angle of attack values are provided for use with the Angle of Attack Display. Angle of attack values are shown to the nearest tenth of a degree.

All Engines

Long Range Cruise Maximum Operating Altitude

These tables provide the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. Note that these tables consider both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 100 ft/min residual rate of climb.

For FAA operators adhering to EASA standards, refer to the data for buffet limits corresponding to a maneuver margin of 1.3g (39° bank).

Flying above these altitudes with sustained banks in excess of approximately 13° may cause the airplane to lose speed and/or altitude. The altitudes shown in the table are limited to the maximum certified altitude of 41000 ft.

Long Range Cruise Control

This table provides target %N1, Long Range Cruise Mach number, IAS and standard day fuel flow per engine for the airplane weight and pressure altitude. As indicated by the shaded area, at optimum altitude, .79 Mach approximates the Long Range Cruise Mach schedule.

APU Operation During Flight

For APU operation during flight, increase fuel flow according to the table in the Engine Inoperative text section.

Long Range Cruise Enroute Fuel and Time

Long Range Cruise Enroute Fuel and Time tables are provided to determine remaining time and fuel required to destination. The data is based on Long Range Cruise and .78/280/250 descent. Tables are presented for low altitudes for shorter trip distances and high altitudes for longer trip distances.

To determine remaining fuel and time required, first enter the Ground to Air Miles Conversion table (Table 1) to convert ground distance and enroute wind to an equivalent still air distance. Next, enter the Reference Fuel and Time table (Table 2) with air distance from Table 1 and the desired altitude and read reference fuel and time required. Lastly, enter the Fuel Required Adjustment table (Table 3) with the reference fuel and the actual weight at checkpoint to obtain fuel required to destination.

Long Range Cruise Wind-Altitude Trade

Wind is a factor which may justify operations considerably below optimum altitude. For example, a favorable wind component may have an effect on ground speed which more than compensates for the loss in air range.

Using this table, it is possible to determine the break-even wind (advantage necessary or disadvantage that can be tolerated) to maintain the same range at another altitude and long range cruise speed. The tables make no allowance for climb or descent time, fuel or distance, and are based on comparing ground fuel mileage.

Descent at .78/280/250

Distance and time for descent are shown for a .78/280/250 descent speed schedule. Enter the table with top of descent pressure altitude and read distance in nautical miles and time in minutes. Data is based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach with gear down and landing flaps at the outer marker.

Holding

Target %N1, indicated airspeed and fuel flow per engine information is tabulated for holding with Flaps Up based on the FMC optimum holding speed schedule. This is the higher of the maximum endurance speed and the maneuvering speed. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read %N1, IAS and fuel flow per engine.

Advisory Information

Runway Surface Condition Correlation

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. A table is provided that correlates runway condition code to runway surface condition description and reported braking action that can then be used to determine the appropriate Normal Configuration Landing Distance or Non-Normal Configuration Landing Distance.

Normal Configuration Landing Distance

Tables are provided as advisory information for normal configuration landing distances on dry runways and runways with good, good to medium, medium, medium to poor, and poor reported braking action. Landing distances (reference distances plus adjustments) are 115% of the actual landing distance. The Normal Configuration Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

The reference landing distance is the distance from threshold to complete stop. It includes an air distance allowance from threshold to touchdown associated with a flare time of 7 seconds. The reference distance is based on a reference landing weight and speed at sea level, standard day, zero wind, zero slope, two engine detent No. 2 reverse thrust, and auto or manual speedbrakes.

To use these tables, determine the reference landing distance for the selected braking configuration and reported braking action. Adjust this reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers. Each correction is applied independently to the reference landing distance.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" reported braking action, the airplane may not be able to achieve these deceleration rates. In these cases, runway slope and inoperative reversers influence the stopping distance. It cannot be determined quickly when this will become a factor, therefore it is appropriate to add the effects of slope and inoperative reversers when using the autobrake system.

Non-Normal Configuration Landing Distance

Advisory information is provided to support non-normal configurations that affect landing. Landing distances and adjustments are provided for dry runways and runways with good, good-to-medium, medium, medium-to-poor, and poor reported braking action. Landing distances (reference distances plus adjustments) are representative of the actual landing distance, and are not factored. The Non-Normal Configuration Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

The reference landing distance is the distance from threshold to complete stop. It includes an air distance allowance from threshold to touchdown associated with a flare time of 7 seconds. The reference distance is based on a reference landing weight and speed at sea level, standard day, zero wind, zero slope, and maximum available reverse thrust.

Tables for Non-Normal Configuration Landing Distance in this section are similar in format and used in the same manner as tables for the Normal Configuration Landing Distance previously described.

For an engine inoperative landing, check the rate of climb capability shown in Gear Down Landing Rate of Climb Available tables to ensure adequate climb performance.

Recommended Brake Cooling Schedule

Advisory information is provided to assist in avoiding problems associated with hot brakes. For normal operation, most landings are at weights below the AFM quick turnaround limit weight.

Use of the recommended cooling schedule will help avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Enter the Reference Brake Energy table (Table 1) with the airplane weight and brakes on speed, adjusted for wind, at the appropriate temperature and altitude condition. Instructions for applying wind adjustments are included below the table. Linear interpolation may be used to obtain intermediate values. The resulting number is the reference brake energy per brake in millions of foot-pounds, and represents the amount of energy absorbed by each brake during a rejected takeoff.

To determine the energy per brake absorbed during landing, enter the Event Adjusted Brake Energy table (Table 2) for no reverse thrust or 2 engine reverse thrust with the reference brake energy per brake and the type of braking used during landing (Max Manual, Max Auto, or Autobrake). The resulting number is the adjusted brake energy per brake and represents the energy absorbed in each brake during the landing. The recommended cooling time is found in the final table (Table 3) by entering with the adjusted brake energy per brake. Times are provided for ground cooling and inflight gear down cooling.

Brake Temperature Monitor System (BTMS) indications are also shown. If brake cooling is determined from the BTMS, use the hottest brake indication 10 to 15 minutes after the airplane has come to a complete stop, or inflight with gear retracted to determine recommended cooling schedule.

Engine Inoperative

Initial Max Continuous %N1

The Initial Max Continuous %N1 setting for use following an engine failure is shown. The table is based on the typical all engine cruise speed of .79 Mach to provide a target %N1 setting at the start of driftdown. Once driftdown is established, the Max Continuous %N1 table should be used to determine %N1 for the given conditions.

Max Continuous %N1

Power setting is based on one engine operating with one A/C pack operating and all anti-ice bleeds off. Enter the table with pressure altitude, TAT, and IAS or Mach to read %N1. Power settings may be interpolated for intermediate airspeeds. %N1 bleed corrections are provided per pressure altitude.

It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating. The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously.

Driftdown Speed/Level Off Altitude

The table shows optimum driftdown speed as a function of cruise weight at start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off considering 100 ft/min residual rate of climb.

The level off altitude is dependent on air temperature (ISA deviation).

Driftdown/LRC Cruise Range Capability

This table shows the range capability from the start of driftdown. Driftdown is continued to level off altitude. As weight decreases due to fuel burn, the airplane is accelerated to long range cruise speed. Cruise is continued at level off altitude and long range cruise speed.

To determine fuel required, enter the Ground to Air Miles Conversion table (Table 1) with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Then enter the Driftdown/Cruise Fuel and Time table (Table 2) with air distance and weight at start of driftdown to determine fuel and time required. If altitudes other than the level off altitude is used, fuel and time required may be obtained by using the Engine Inoperative Long Range Cruise Diversion Fuel and Time table.

Long Range Cruise Altitude Capability

The table shows the maximum altitude that can be maintained at a given weight and air temperature (ISA deviation), based on LRC speed, Max Continuous thrust, and 100 ft/min residual rate of climb.

Long Range Cruise Control

The table provides target %N1, engine inoperative Long Range Cruise Mach number, IAS and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect single engine fuel burn.

APU Operation During Flight

For APU operation during flight, increase fuel flow according to the following table. These increments include the APU fuel flow and the effect of increased drag from the APU door.

PRESSURE ALTITUDE (1000 FT)	APU FUEL FLOW (KG/HR)
39	45
35	45
31	50
25	60
20	65
15	75
10	85
5	95

Long Range Cruise Diversion Fuel and Time

Tables are provided for crews to determine the fuel and time required to proceed to an alternate airfield with one engine inoperative. The data is based on single engine Long Range Cruise speed and .78/280/250 descent.

To determine the remaining fuel and time required, first enter the Ground to Air Miles Conversion table (Table 1) to convert ground distance and enroute wind to an equivalent still air distance. Next, enter the Reference Fuel and Time table (Table 2) with air distance from Table 1 and the desired altitude and read reference fuel and time required. Lastly, enter the Fuel Required Adjustment table (Table 3) with the reference fuel and the actual weight at checkpoint to obtain fuel required to destination.

Holding

Single engine holding data is provided in the same format as the all engine holding data and is based on the same assumptions.

Gear Down Landing Rate of Climb Available

Rate of climb data is provided as guidance information in the event an engine inoperative landing (manual or autoland) is planned. The tables show gear down rate of climb available for Flaps 15 and Flaps 30. Enter the table with TAT and pressure altitude to read rate of climb available. Apply adjustments shown to correct for weight.

Alternate Mode EEC

Introduction

This section contains performance data for airplane operation with the Electronic Engine Control (EEC) in the alternate mode (ALTN EEC switch illuminated) for applicable thrust ratings. The data includes engine bleed effects for normal air conditioning operation i.e., two packs on at normal flow all engines operating.

Operation with assumed temperature reduced thrust is not permitted with the EEC in the alternate mode.

Limit Weight

A simplified method which conservatively accounts for the effects of EEC in the ALTERNATE mode is to reduce the normal mode performance limited weights. The Limit Weight table provides takeoff field, climb, obstacle, tire speed and brake energy weights. No adjustment is necessary for weight limits not shown. To determine limit weights for operations with the EEC in the ALTERNATE mode, enter the table with each of the limit weights for normal mode EEC operation and read the associated limit weight for each performance condition. The most limiting of the takeoff weights must be used.

Derated or reduced takeoff thrust takeoffs are not allowed with the EEC in the ALTERNATE mode. Adjustments to the limit weights provided in this section are not valid for takeoffs using improved climb. Likewise, adjustments to the limit weights are not valid for takeoffs with a contaminated runway. Analysis from the Airplane Flight Manual - Digital Performance Information may yield less restrictive limit weights.

Takeoff Speed Adjustment

Takeoff speeds computed for the reduced weight need no further adjustment.

Max Takeoff %N1

To find alternate mode EEC Max Takeoff %N1 based on normal engine bleed for air conditioning packs on, enter the Alternate Mode EEC Max Takeoff %N1 table with airport pressure altitude and airport OAT and read %N1. Apply %N1 adjustments as provided when applicable.

Max Climb %N1

To find alternate mode EEC Max Climb %N1 based on normal engine bleed for air conditioning packs on, enter the Alternate Mode EEC Max Climb %N1 table with airport pressure altitude and TAT and read %N1. Apply %N1 adjustments as provided when applicable.

Go-Around %N1

Go-Around power setting for ALTERNATE MODE EEC operation is presented for bleed packs on (AUTO) and anti-ice off. Go-Around %N1 may be read directly from the tables for the desired pressure altitude and airport OAT.

The ALTERNATE MODE EEC schedule provides equal or greater thrust than the normal mode for the same lever position. Thrust protection is not provided in the ALTERNATE mode and maximum rated thrust is reached at a thrust lever position less than full forward. As a result, thrust overboost can occur at full forward thrust lever positions.

Alternate Mode EEC, Engine Inoperative

Initial Max Continuous %N1

Initial Max Continuous %N1 settings for use following an engine failure are presented. The table is based on the typical all engine cruise speed of .79 Mach to provide a target %N1 setting at the start of driftdown. Once driftdown is established, the Max Continuous %N1 table should be used to determine %N1 for the given conditions.

Max Continuous %N1

Power setting is based on one engine operating with one A/C pack operating and all anti-ice bleeds off. Enter the table with pressure altitude, TAT, and IAS or Mach to read %N1. Power settings may be interpolated for intermediate airspeeds. %N1 bleed corrections are provided per pressure altitude.

It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating. The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously.

Gear Down

This section contains performance for airplane operation with the landing gear extended for all phases of flight.

Note: The Flight Management System (FMS) does not contain special provisions for operation with landing gear extended. As a result, the FMS will generate inaccurate enroute speed schedules, display non-conservative predictions of fuel burn, estimated time of arrival (ETA), maximum altitude, and compute overly shallow descent path. An accurate estimated time of arrival is available if current speed or Mach is entered into the VNAV cruise page. Estimates of fuel remaining at waypoints or the destination may be computed by the crew based on current fuel flow indications, but should be updated frequently.

Tables for gear down performance in this section are identical in format and used in the same manner as tables for the gear up configuration previously described.

Gear Down, Engine Inoperative

This section contains performance for airplane operation with the landing gear extended for use following an engine failure.

The caution provided in the Gear Down section for use of the FMS in a gear down situation is still applicable.

Tables for gear down, engine inoperative performance in this section are identical in format and used in the same manner as tables for the gear up, engine inoperative configuration previously described.

Airplane General, Emergency Equipment, Doors, Windows — Chapter 1

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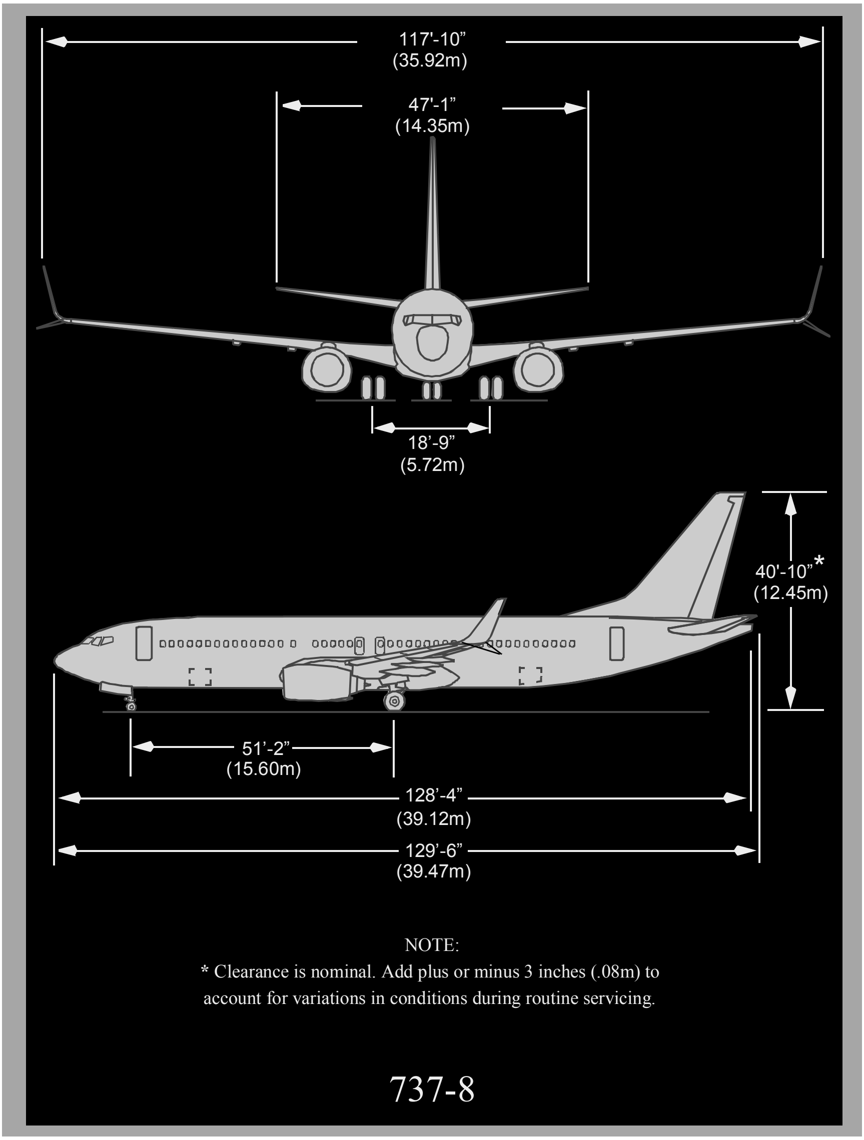
Principal Dimensions



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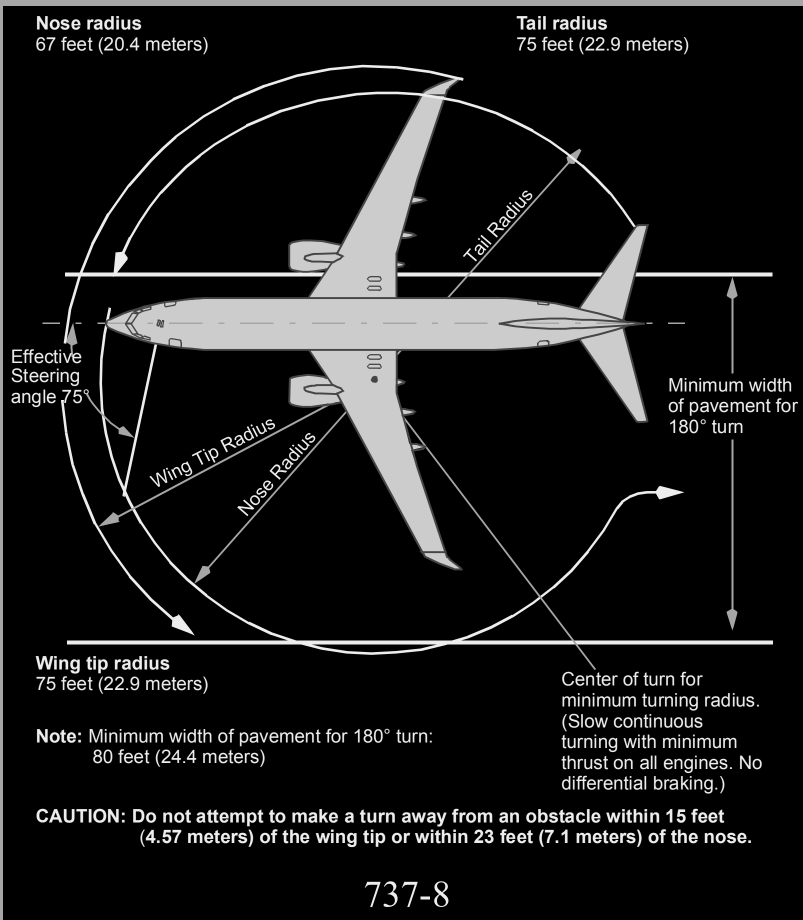
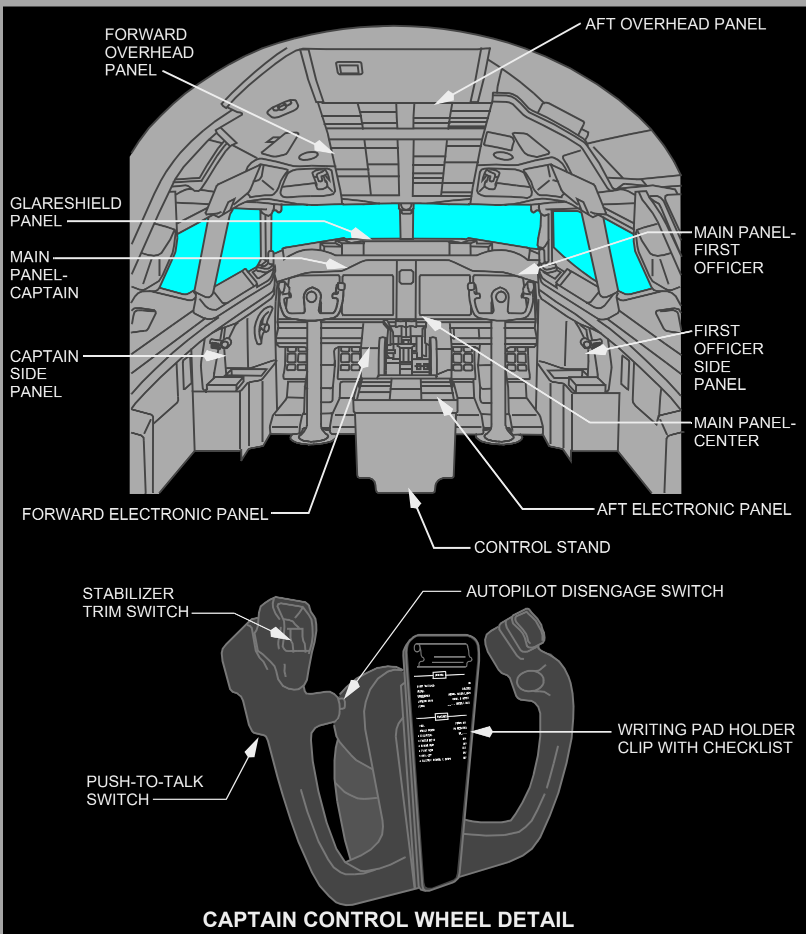


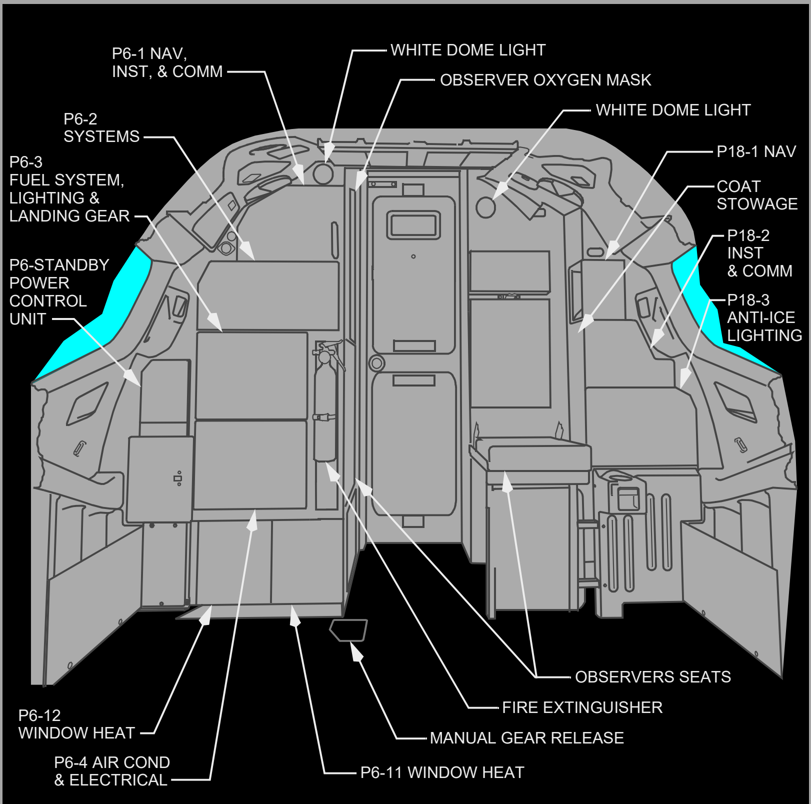
Panel Arrangement



On the following pages, circled numbers refer to chapters where information on the item may be found.

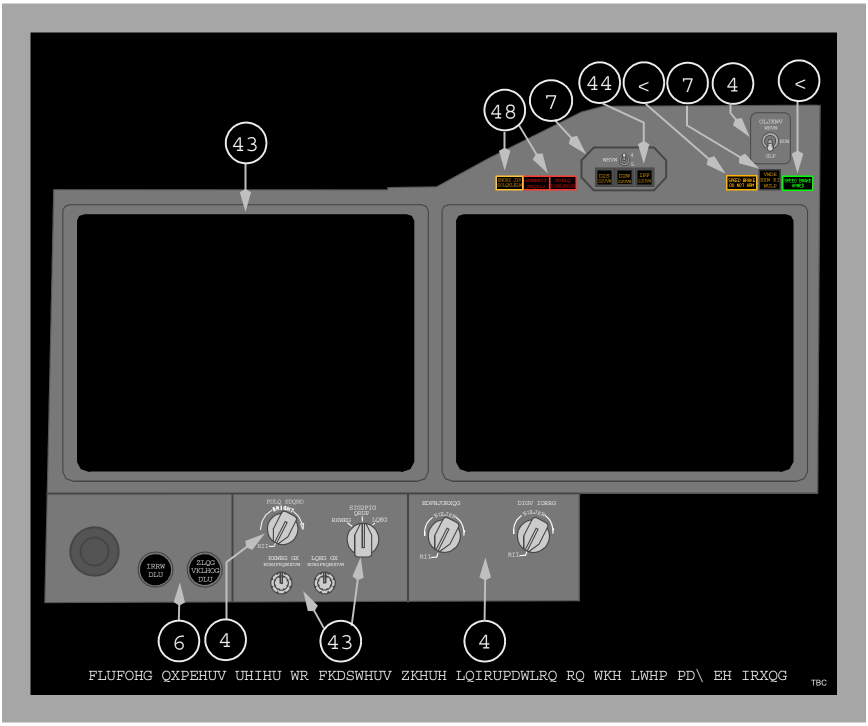
The panels, controls, and indicators shown in this chapter are representative of installed units and may not exactly match the latest configuration. Refer to the appropriate chapter system descriptions for current information.

Aft Flight Deck Overview

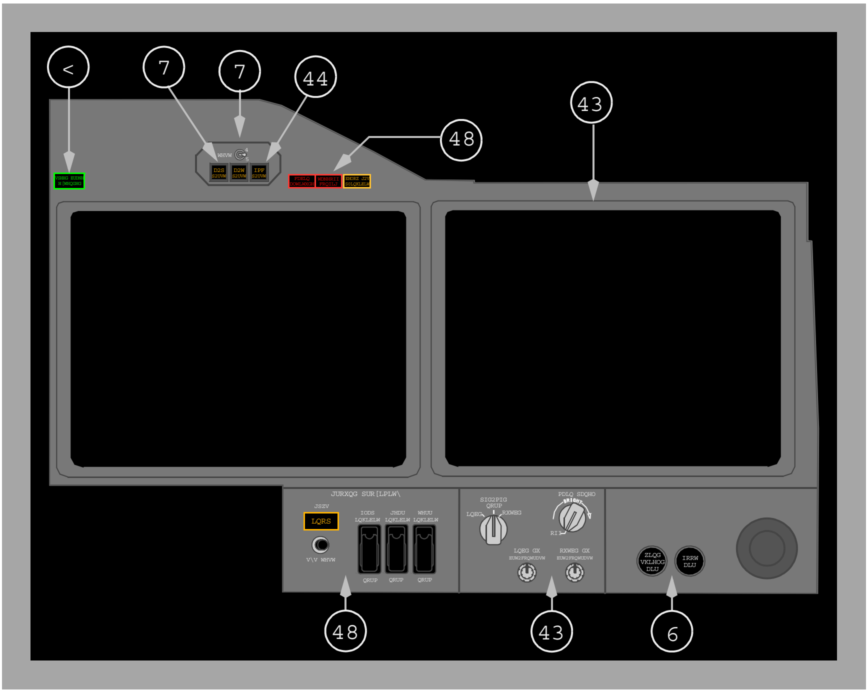


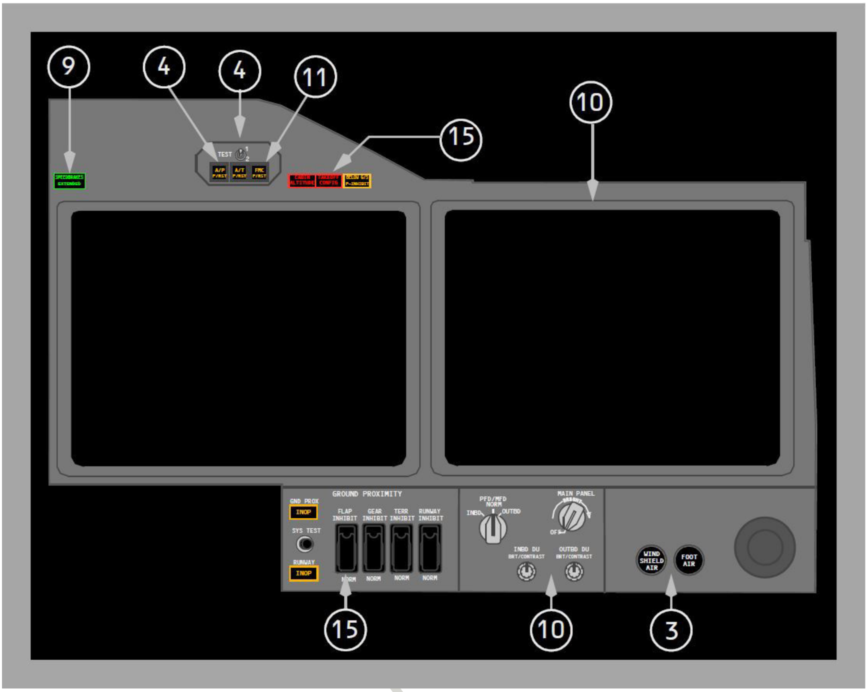
AFT FLIGHT DECK OVERVIEW

Main Panel - Captain



Main Panel - First Officer

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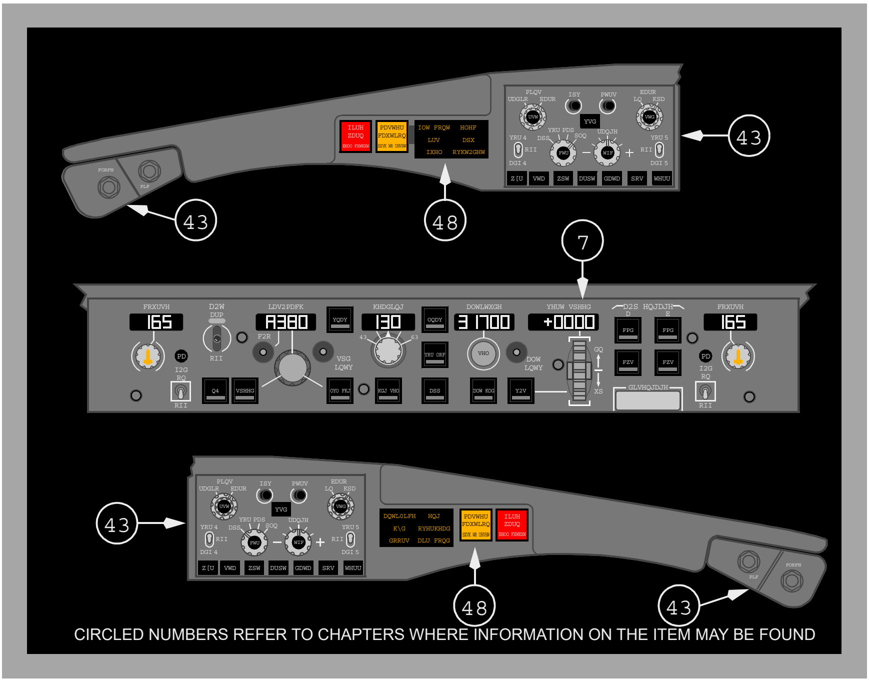
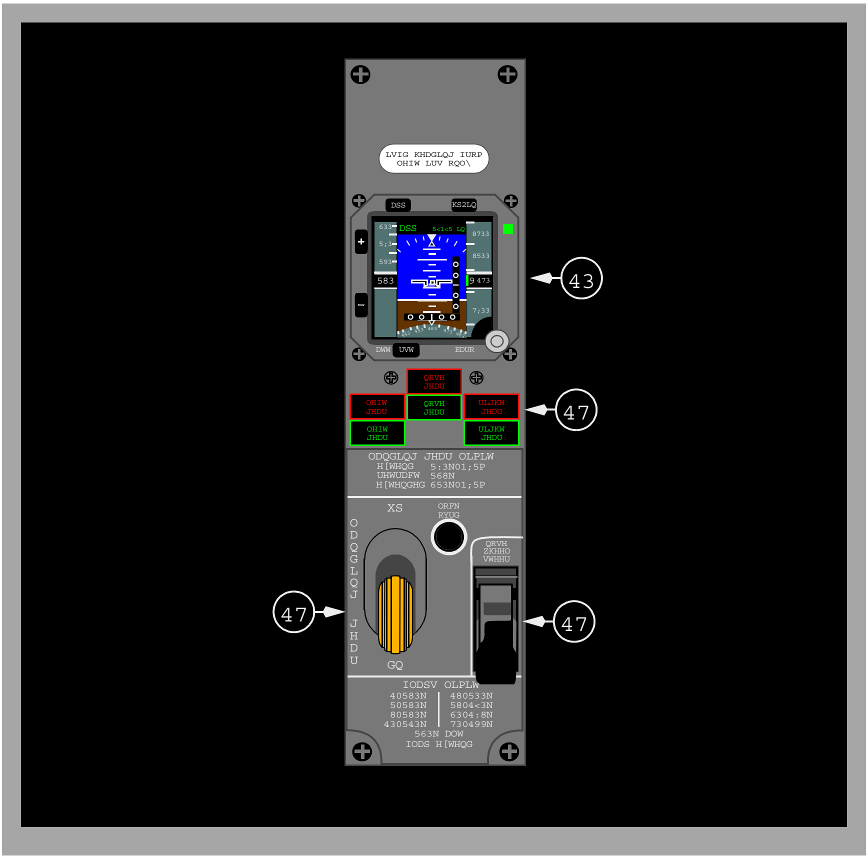
15
10
SPEEDBRAKES EXTENDED
TEST
1
2
A/P P/RST
A/T P/RST
FMC P/RST
CABIN ALTITUDE
TAKEOFF CONFIG
BELOW G/S P-INHIBIT
GROUND PROXIMITY
GND PROX
INOP
SYS TEST
RUNWAY
INOP
FLAP INHIBIT
GEAR INHIBIT
TERR INHIBIT
RUNWAY INHIBIT
NORM
NORM
NORM
NORM
PFD/MFD
NORM
INBD
OUTBD
MAIN PANEL
OFF
INBD DU BRT/CONTRAST
OUTBD DU BRT/CONTRAST
WIND SHIELD AIR
FOOT AIR
15
10
3

Glareshield Panel

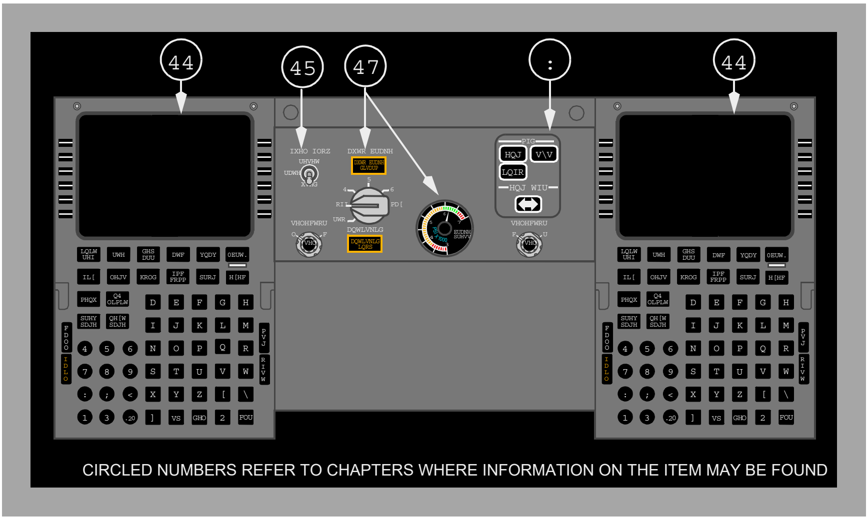


CIRCLED NUMBERS REFER TO CHAPTERS WHERE INFORMATION ON THE ITEM MAY BE FOUND

Main Panel - Center

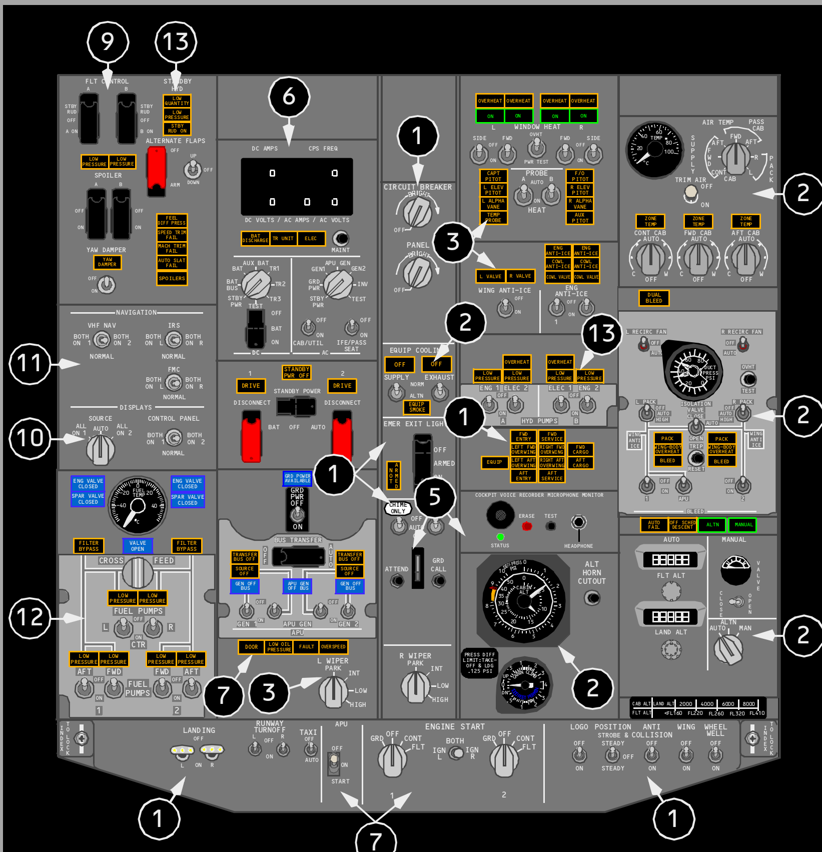


Forward Electronic Panel



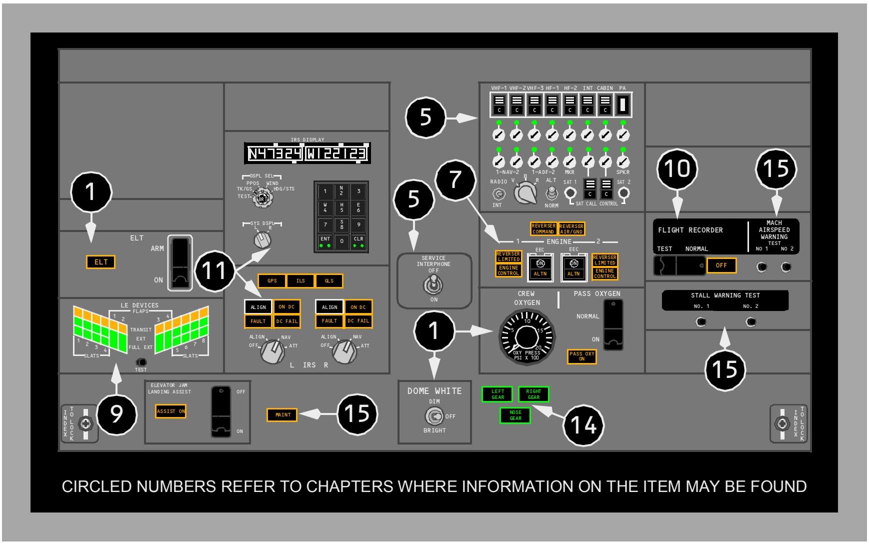
CIRCLED NUMBERS REFER TO CHAPTERS WHERE INFORMATION ON THE ITEM MAY BE FOUND

Forward Overhead Panel

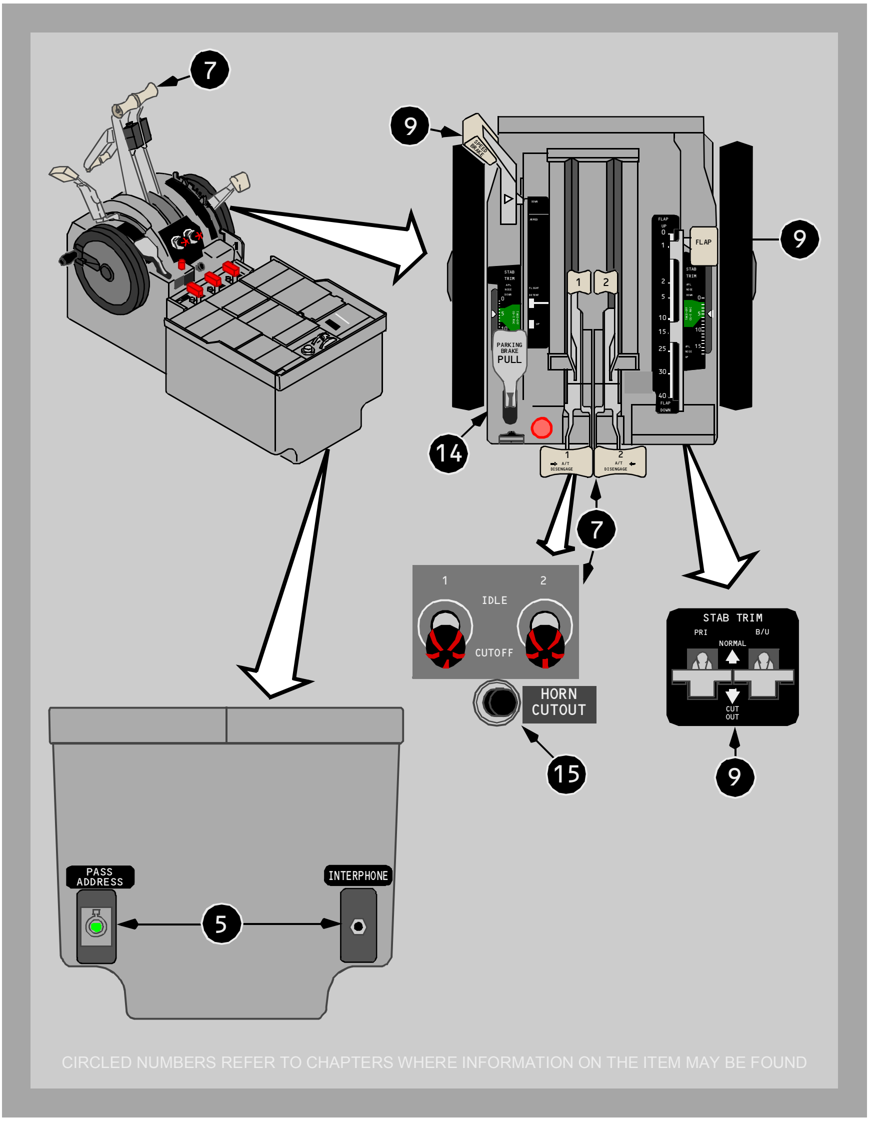


CIRCLED NUMBERS REFER TO CHAPTERS WHERE INFORMATION ON THE ITEM MAY BE FOUND

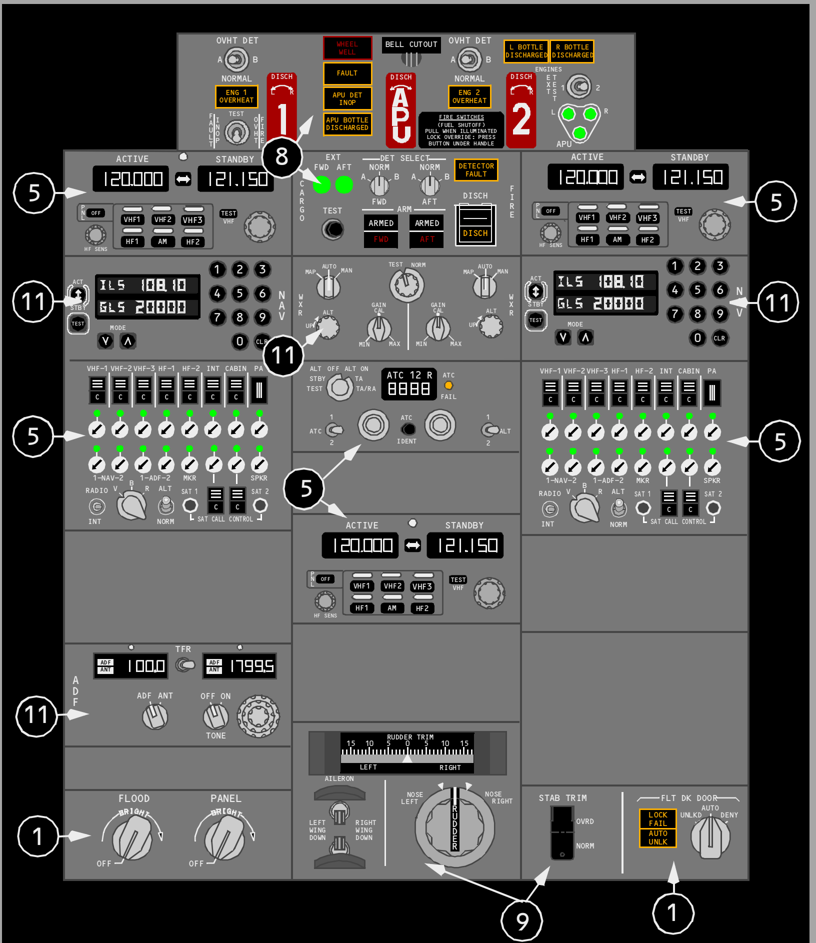
Aft Overhead Panel



Control Stand

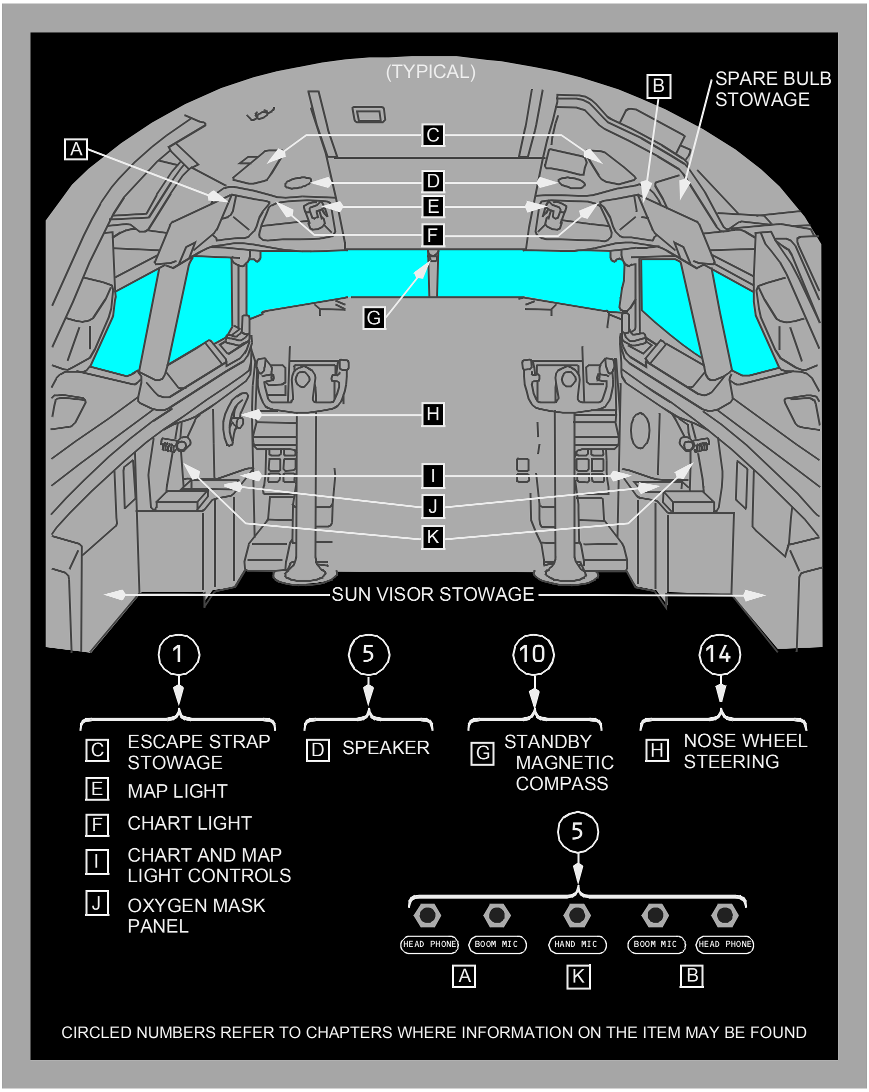


Aft Electronic Panel

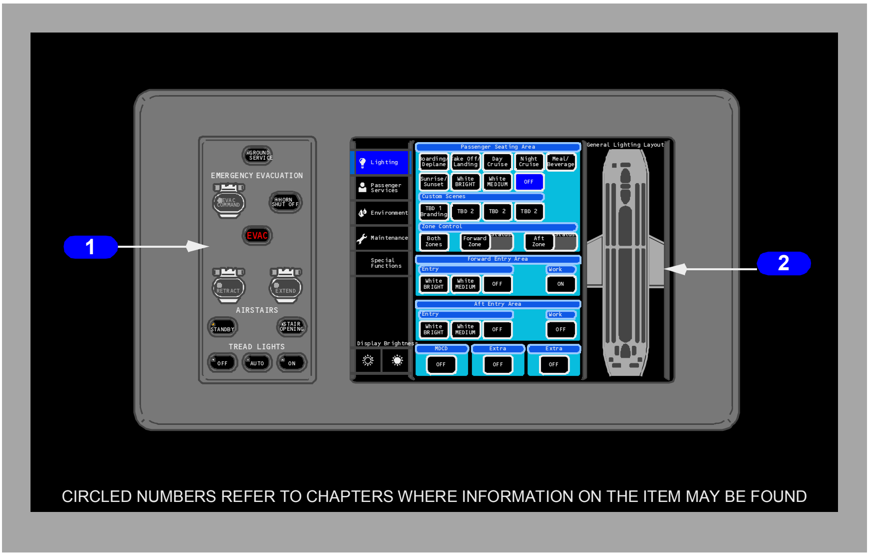


CIRCLED NUMBERS REFER TO CHAPTERS WHERE INFORMATION ON THE ITEM MAY BE FOUND

Auxiliary Panels



Attendant Control Panels
Forward Attendant Control Panel



CIRCLED NUMBERS REFER TO CHAPTERS WHERE INFORMATION ON THE ITEM MAY BE FOUND

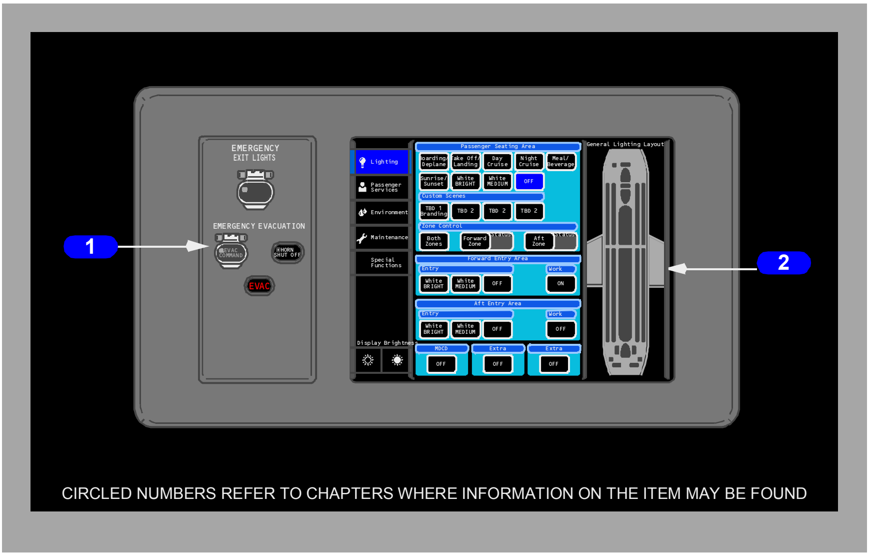
1 Pushbutton Panel Controls

This is a typical grouping of pushbutton cabin controls.

2 Touch Screen

Touch screen controls various functions such as Lighting, Passenger Services, Environment, Maintenance and Special Functions. A typical Lighting menu is depicted.

Aft Attendant Control Panel



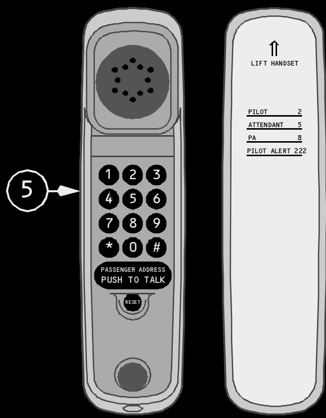
1 Pushbutton Panel Controls

This is a typical grouping of pushbutton cabin controls.

2 Touch Screen

Touch screen controls various functions such as Lighting, Passenger Services, Environment, Maintenance and Special Functions. A typical Lighting menu is depicted.

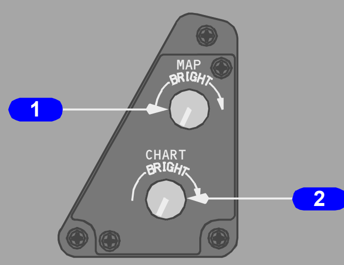
Attendant Handset



CIRCLED NUMBERS REFER TO CHAPTERS WHERE INFORMATION ON THE ITEM MAY BE FOUND

Flight Deck Lighting

Map and Chart Light Controls



SIDEWALL PANELS

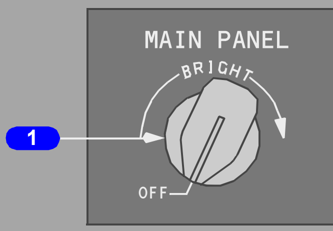
1 MAP Light Control

Rotate – adjusts brightness of Captain/First Officer map lights

2 CHART Light Control

Rotate – adjusts brightness of Captain/First Officer chart lights

Main Panel Lighting



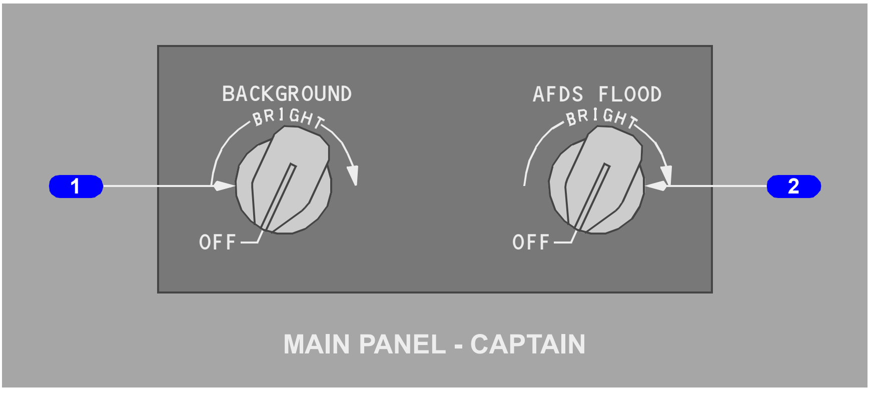
MAIN PANEL - CAPTAIN/FIRST OFFICER

1 MAIN PANEL Light Control

Rotate –

- Captain – controls brightness of Captain's panel and instrument lighting, center instrument panel, and AFDS panel displays and edge lighting
- First Officer – controls brightness of First Officer's panel and instrument lighting.

Background and AFDS Flood Light Control



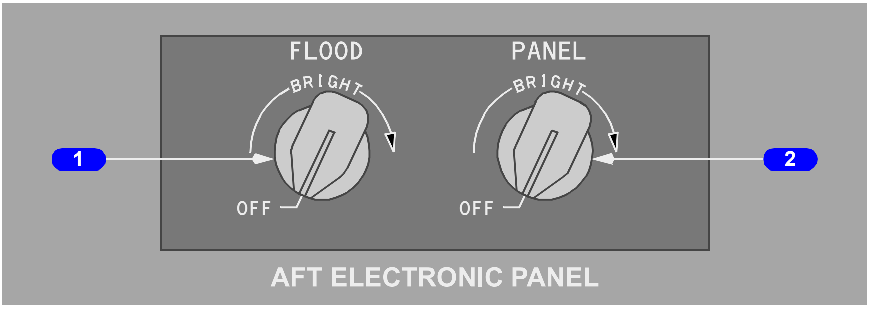
1 BACKGROUND Light Control

Rotate – controls incandescent lighting brightness for Captain's panel, First Officer's panel, and center panel.

2 AFDS FLOOD Light Control

Rotate – controls brightness of lighting directed at AFDS panel.

Flood and Aft Electronics Lights Controls



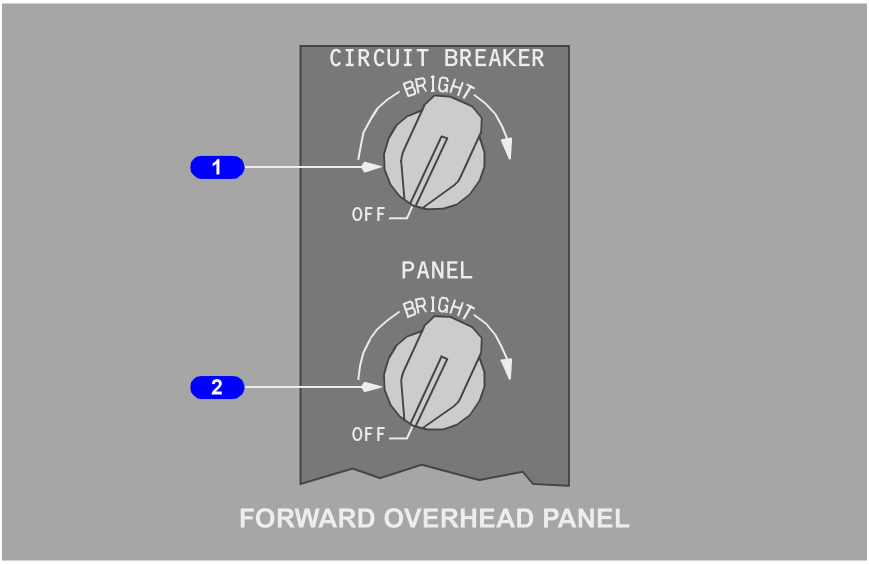
1 **FLOOD Light Control**

Rotate – controls overhead spotlight brightness directed at the control stand and aft electronic panel.

2 **PANEL Light Control**

Rotate – controls forward and aft electronic control panel lights brightness.

Overhead/Circuit Breaker Panel Light Controls



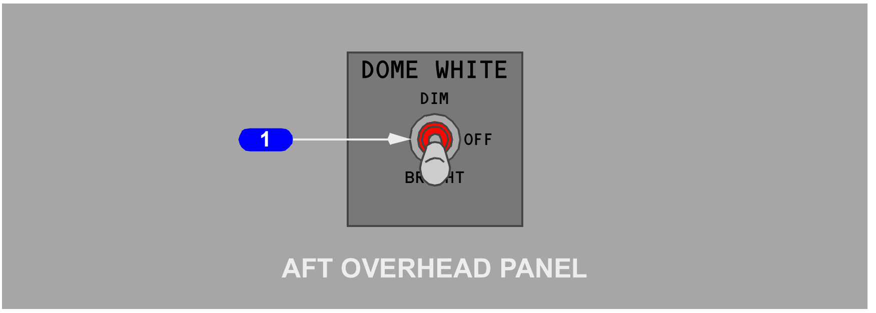
1 **CIRCUIT BREAKER Light Control**

Rotate – controls P–6 and P–18 circuit breaker panels light brightness.

2 **PANEL Light Control**

Rotate – controls forward and aft overhead panel lights brightness.

Dome Light Control



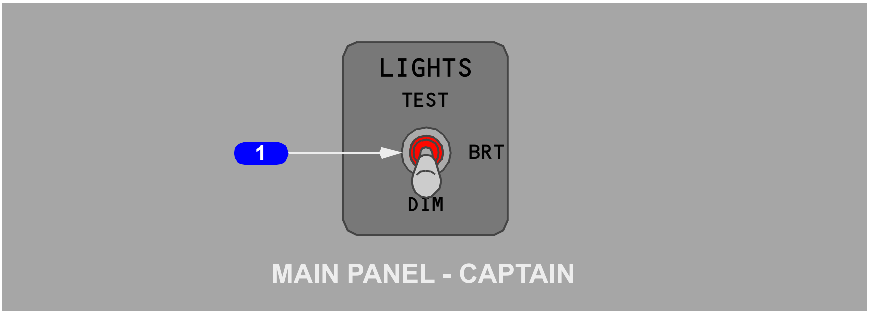
1 DOME Light Control

DIM – sets overhead dome lights to low brightness.

OFF – overhead dome lights are extinguished.

BRIGHT – sets overhead dome lights to full brightness.

Master Lights Test and Dim Switch



1 Master LIGHTS TEST and DIM SWITCH

TEST – illuminates all system lights on forward and aft overhead panels, and some lights on Captain and First Officer main panels to full brightness.

BRT (bright) – sets all system lights on forward and aft overhead panels, and some lights on Captain and First Officer panels to full brightness.

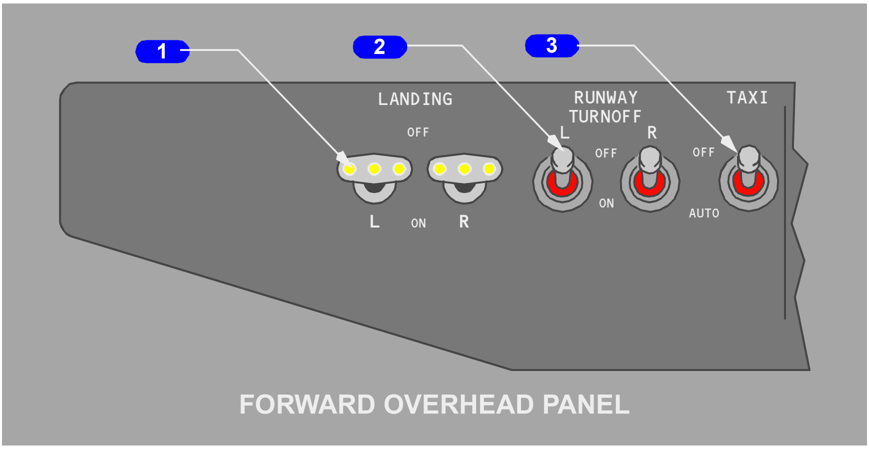
DIM – sets all system lights on forward and aft overhead panels, and some lights on Captain and First Officer panels to low brightness.

Note: Placing the Master Lights Test and Dim Switch in the TEST position will result in a master caution recall and any stored fault will cause the associated light to remain illuminated when the switch is released.

Exterior Lighting

LED - Landing, Taxi and Runway Turnoff Lights

The Landing, Taxi and Runway Turnoff Lights are located in each wing root strakelet and provide the lighting necessary for airplane operation.



1 LANDING Light Switch

OFF – fixed landing lights are extinguished.

ON – fixed landing lights are illuminated.

2 RUNWAY TURNOFF Light Switch

OFF – runway turnoff lights are extinguished.

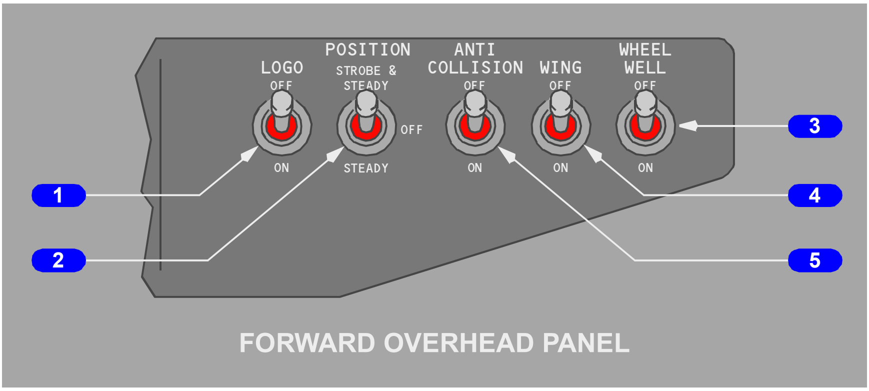
ON – runway turnoff lights are illuminated.

3 TAXI Light Switch

OFF – wing strakelet taxi light extinguished.

AUTO – wing strakelet taxi lights are illuminated when the nose landing gear is fully extended and are extinguished when the nose landing gear retracts.

Miscellaneous Exterior Lights



1 LOGO Light Switch

OFF – logo lights on each side of vertical fin extinguished.

ON – logo lights illuminated.

2 POSITION Light Switch

STROBE & STEADY – red and green wingtip position lights, white trailing edge wingtip lights, white tailcone lights, winglet aft marker lights, and wingtip and tailcone strobe lights illuminated.

OFF – red and green wingtip position lights, white trailing edge wingtip lights and wingtip, winglet aft marker lights, and tail strobe lights extinguished.

STEADY – red and green wingtip position lights, winglet aft marker lights, and white trailing edge wingtip lights illuminated.

3 WHEEL WELL Light Switch

OFF – three wheel well lights extinguished.

ON – wheel well lights illuminated.

4 WING Illumination Switch

OFF – wing leading edge lights on fuselage forward of wing extinguished.

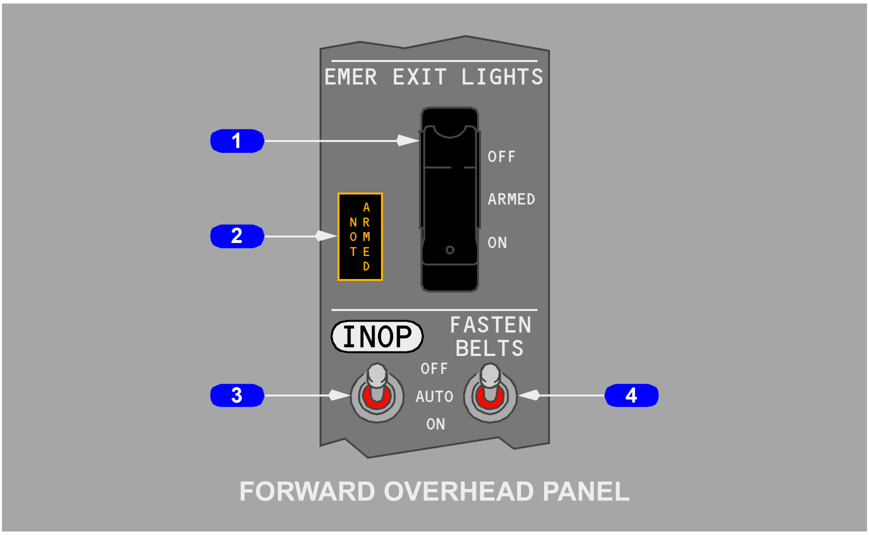
ON – wing leading edge lights illuminated.

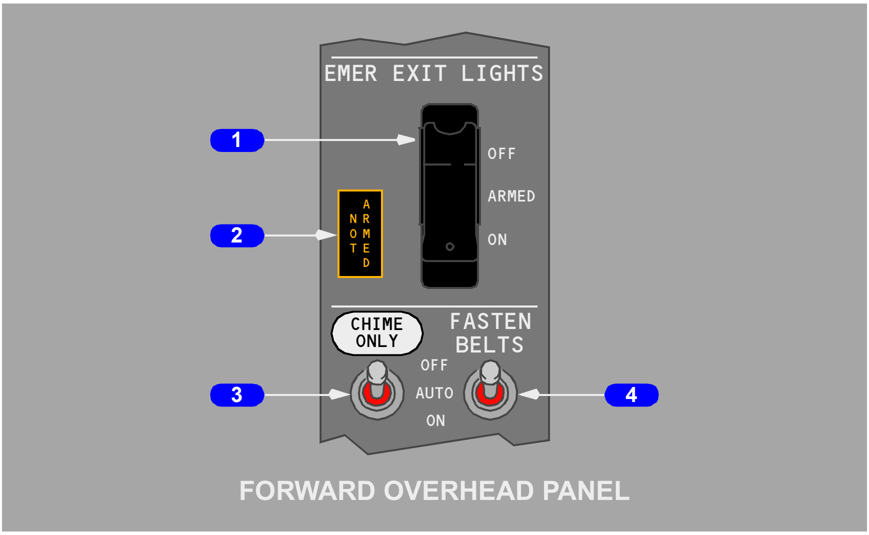
5 ANTI–COLLISION Light Switch

OFF – red strobe/rotating beacon lights on upper and lower fuselage extinguished.

ON – red strobe/rotating beacon lights illuminated.

Emergency Lighting and Passenger Signs
Flight Deck





1 Emergency (EMER) EXIT LIGHTS Switch

OFF – prevents emergency lights system operation if airplane electrical power fails or is turned off.

ARMED – (guarded position) all emergency lights illuminate automatically if airplane electrical power to DC bus No. 1 fails or AC power is turned off.

ON – all emergency lights illuminate.

2 Emergency (EMER) EXIT LIGHTS NOT ARMED Light

Illuminated (amber) – EMER EXIT LIGHTS switch not in ARMED position.

3 NO SMOKING Switch (INOP Placard installed)

The No Smoking signs are deactivated and placarded INOP.

3 NO SMOKING Switch (CHIME ONLY placard installed)

The No Smoking signs permanently indicate smoking is not allowed.

ON - a low chime sounds in the cabin.

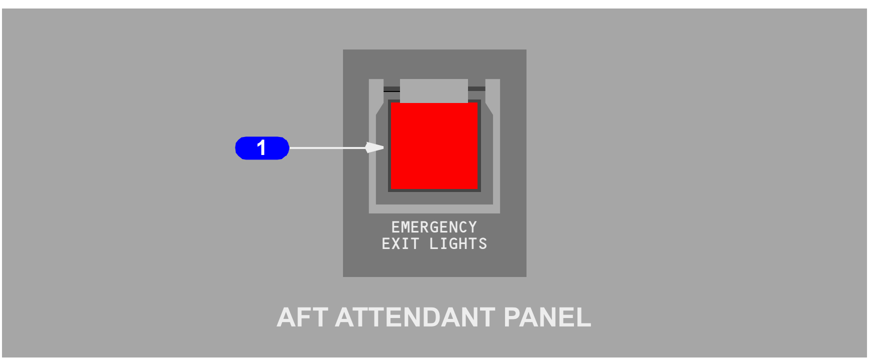
4 FASTEN BELTS Switch

OFF – the FASTEN SEAT BELTS and RETURN TO SEAT signs are not illuminated.

AUTO – the FASTEN SEAT BELTS and RETURN TO SEAT signs are illuminated or extinguished automatically with reference to airplane configuration (refer to the Lighting System Description section).

ON – the FASTEN SEAT BELTS and RETURN TO SEAT signs are illuminated.

Passenger Cabin



1 Passenger Cabin Emergency Lights Switch (guarded)

On – illuminates all emergency lights and bypasses flight deck control.

Emergency Locator Transmitter

1 Emergency Locator Transmitter Light

Illuminated (amber) – ELT has been activated and is simultaneously transmitting tone and position data (as installed) on 121.5, 243.0 and 406.0 MHz.

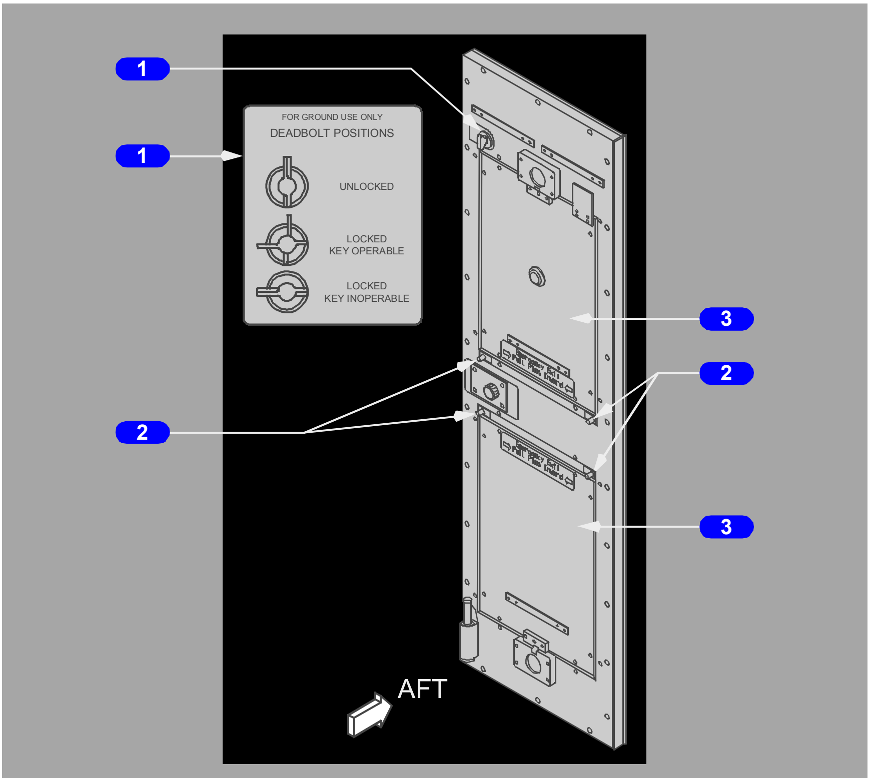
2 Emergency Locator Transmitter Switch

ARM – (guarded position) ELT transmits automatically when it reaches its preset G–Load limit.

ON – manually activates the ELT.

Doors

Flight Deck Door



FLIGHT DECK DOOR

1 Deadbolt and Deadbolt Placard

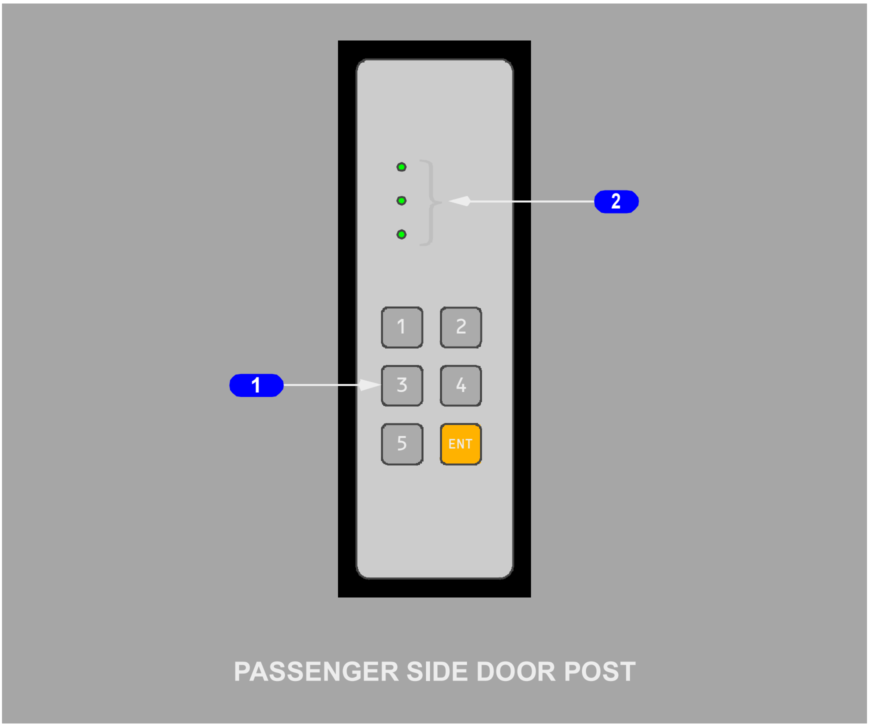
2 Release Pins

Pull pins inward - manually separates decompression panel from a jammed door to allow panel opening and egress.

3 Decompression Panel

Provides emergency egress path and automatically opens during airplane decompression.

Flight Deck Emergency Access Panel



1 Keypad

Push - enters 3 to 8 digit emergency access code by pressing numeric then “ENT” keys. Entry of correct emergency access code sounds flight deck chime.

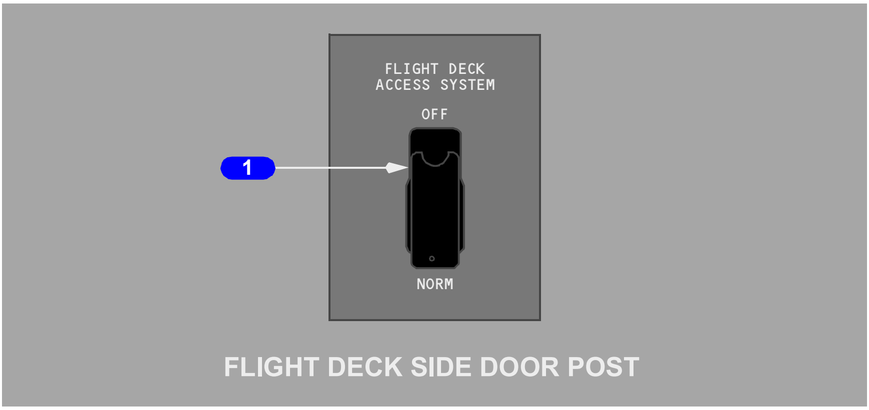
2 Access Lights

Illuminated (red) - door locked or Flight Deck Access System switch OFF.

Illuminated (amber) - correct emergency access code entered.

Illuminated (green) - door unlocked.

Flight Deck Access System Switch

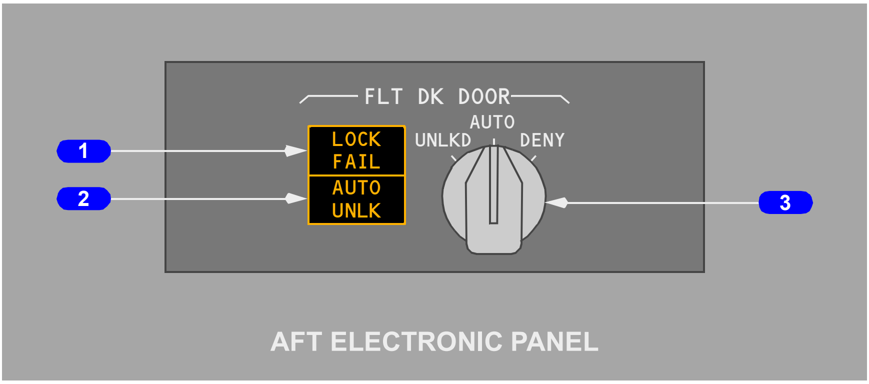


1 Flight Deck Access System Switch

OFF - removes electrical power from door lock.

NORM (Normal) - flight deck access system configured for flight.

Flight Deck Door Lock Panel



1 LOCK FAIL Light

Illuminated (amber) - Flight Deck Door Lock selector in AUTO and door lock has failed or Flight Deck Access System switch is OFF.

2 AUTO Unlock (UNLK) Light

Illuminated (amber) - correct emergency access code entered in keypad. AUTO UNLK light flashes and continuous chime sounds before timer expires and door unlocks.

3 **Flight Deck (FLT DK) Door Lock Selector**

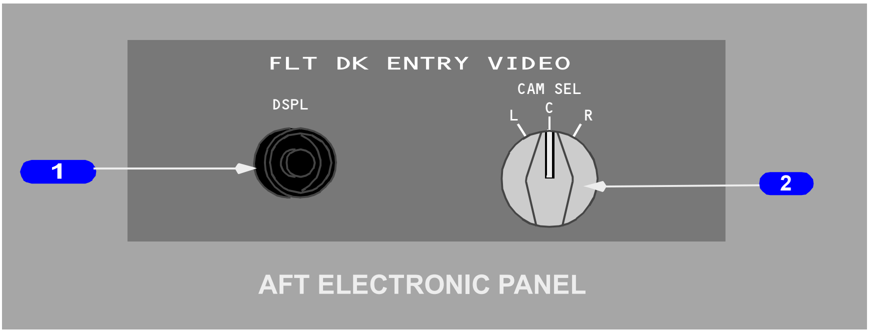
Spring loaded to AUTO. Selector must be pushed in to rotate from AUTO to UNLKD. Selector must not be pushed in to rotate from AUTO to DENY.

UNLKD - door unlocked while selector in UNLKD.

AUTO - door locked. Allows door to unlock after entry of emergency access code and expiration of timer, unless crew takes action.

DENY - rejects keypad entry request and prevents further emergency access code entry for a time period.

Flight Deck Entry Video Panel



1 **Display Switch (DSPL)**

Push - displays video image on either the left or right inboard Display Unit (DU) opposite of the inboard DU with Engine Display displayed. The image can be transferred between the left and right inboard Display Units by selecting the ENG TFR button on the Engine Display Control Panel.

Second Push - cancels video image on either the left or right inboard display unit.

Note: The IFE/PASS switch must be in the ON position for the flight deck entry camera to be displayed on the display units.

2 **Camera Selector (CAM SEL)**

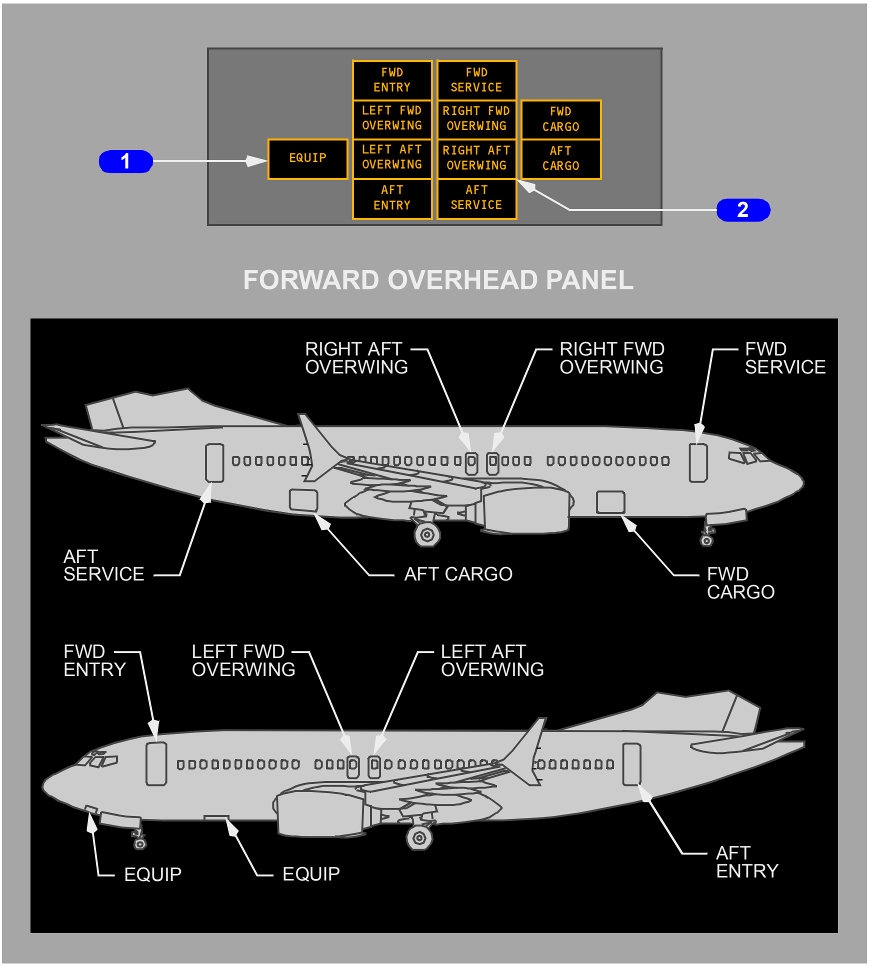
Selects video surveillance camera view on the selected inboard Display Unit (DU).

L - provides a view of the flight deck door with a back view of the person requesting entry.

C - provides a frontal view of the person requesting entrance (assuming the person is facing the flight deck door).

R - provides a general view of the forward service door galley area.

Exterior Door Annunciator Lights



1 Exterior Door Annunciations

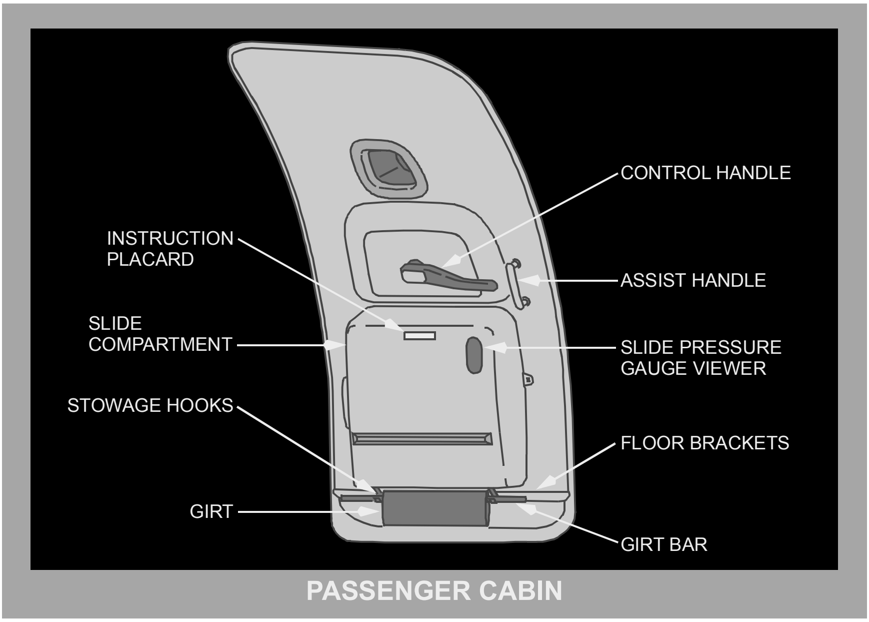
Illuminated (amber) – related door is not closed and locked.

2 Overwing Exit Annunciations

Illuminated (amber) –

- related overwing exit is not closed and locked
- related flight lock failed to engage when commanded locked.

Passenger Entry/Galley Service Doors



Oxygen

Oxygen Panel

1 Flight CREW OXYGEN Pressure Indicator

Indicates pressure at the crew oxygen cylinder.

2 Passenger Oxygen (PASS OXYGEN) Switch

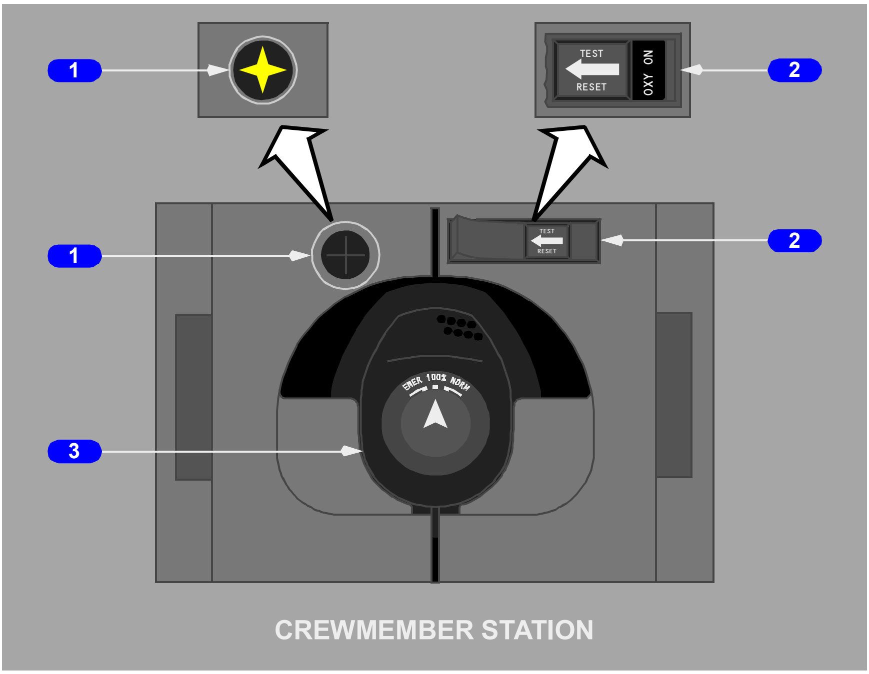
NORMAL – (guarded position) passenger masks drop and passenger oxygen system activated automatically if cabin altitude climbs to 14,000 feet

ON – activates system and drops masks if automatic function fails.

3 Passenger Oxygen On Light

Illuminated (amber) – passenger oxygen system is operating and masks have dropped.

Oxygen Mask Panel



1 Oxygen Flow Indicator

Indicates a colored cross when oxygen is flowing.

2 TEST/RESET Switch

Push –

- with the left oxygen mask panel door closed and the OXY ON flag not displayed, turns oxygen on momentarily to test the regulator
- with the left oxygen mask panel door closed and the OXY ON flag displayed will turn oxygen off and disable the mask microphone and enable the boom microphone.

3 **Regulator and Inflation Lever (Hidden)**

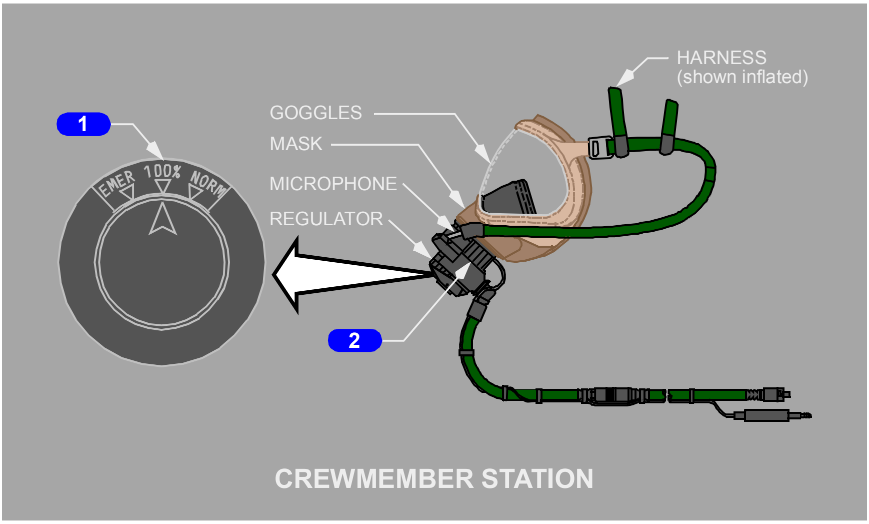
Grasp Regulator and pull up –

- allows mask removal from stowage box
- activates oxygen and microphone when stowage box doors open

Squeeze Inflation Lever –

- inflates harness.

Oxygen Mask and Regulator



1 **Regulator Selector**

Rotate –

- EMER - supplies 100% oxygen under positive pressure at all cabin altitudes. Use to purge contaminants from mask and to remove condensation or fogging from interior of mask lens.
- 100% - supplies 100% oxygen on demand
- NORM - supplies air/oxygen mixture on demand (ratio depends on cabin altitude)

CAUTION: Use of EMER mode depletes oxygen supply at higher rate than 100% or NORM mode. Use EMER mode only as conditions require.

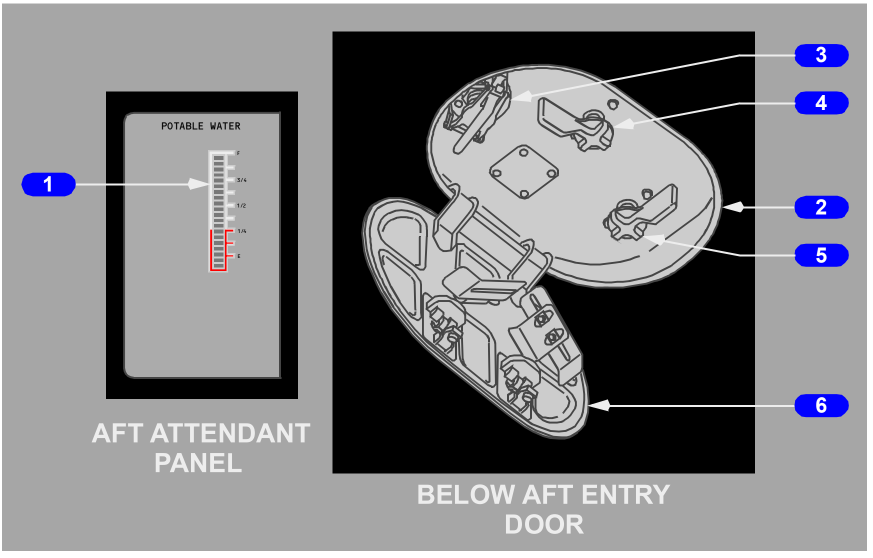
Note: Communications in EMER mode may be difficult. Switch to 100% or NORM if conditions allow.

2 **Inflation Lever**

Squeeze –

- inflates mask harness
- flow indicator shows a colored cross momentarily as harness inflates.
- enables the mask microphone when the left oxygen mask panel door is opened
- disables the boom microphone.

Water System Controls



1 **Water Quantity Indicator**

Indicates quantity of water in reservoir.

2 **Water System Service Panel**

3 **Fill Fitting**

Used to fill tank.

4 **Fill and Overflow Valve Handle**

Open - enables filling or gravity draining water tank.

Closed - normal position.

5 **Tank Drain Valve Handle**

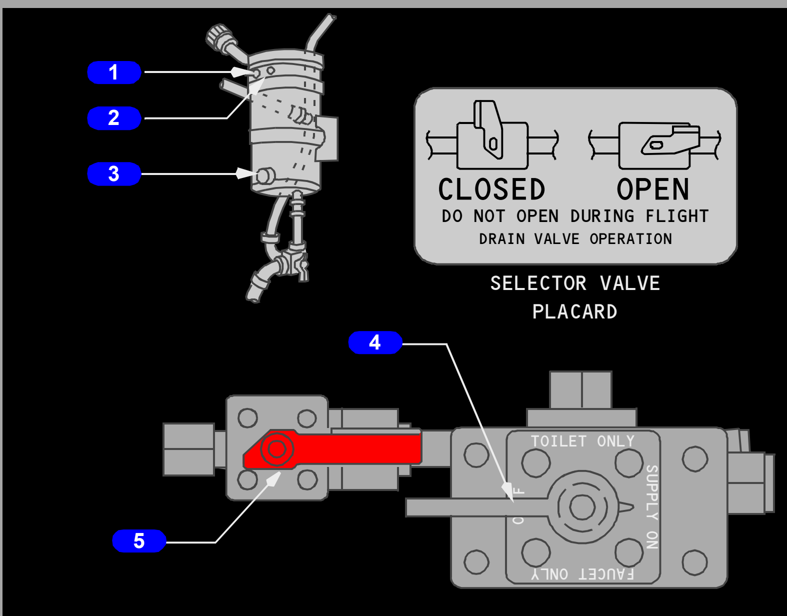
Open - drains water from tank.

Closed - normal position.

6 **Access Panel**

Cannot be closed unless the Fill and Overflow Valve and Tank Drain Valve Handles are in the closed position.

Lavatory Controls



LAVATORY SINK CABINET

1 **Water Heater Switch**

On – activates the water heater.

2 **Water Heater Light**

Illuminated - heater operating.

3 **Temperature Control Switch**

4 Water Supply Selector Valve

Each lavatory has a Water Supply Selector Valve. The Water Supply Selector Valve has four positions, and is located in the cabinet below the sink.

SUPPLY ON – Normal operating position. When the water system is depressurized, all lavatories except "A" will drain. In this lavatory, the drain valve must be opened to drain the lavatory

FAUCET ONLY – In this position, water is supplied to the faucet, but not to the toilet

TOILET ONLY – In this position, water is supplied to the toilet, but not to the faucet

OFF – No water is supplied to the lavatory.

5 Drain Valve Handle (red)

Located in the forward lavatory only.

Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Systems Description — Section 40

Introduction

This chapter describes miscellaneous airplane systems, including:

- lighting systems
- oxygen systems
- fire extinguishers
- emergency equipment
- doors and windows
- cargo compartments
- emergency egress
- flight deck seats
- galleys
- water systems
- lavatories

Lighting Systems

Lighting systems described in this chapter include:

- exterior lighting
- flight deck lighting
- passenger cabin lighting
- emergency lighting.

Exterior Lighting

Exterior lighting consists of these lights:

- landing
- runway turnoff
- taxi
- logo
- position (navigation)
- strobe
- anti–collision
- wing illumination
- winglet aft marker
- wheel well.

Landing, Taxi, and Runway Turnoff Lights

LED lights are mounted in the wing strakelets and provide all function capability of landing, taxi, and runway turnoff light applications for the airplane. When both the landing and taxi lights are in the ON position, the taxi light function is overridden by the landing light function.

Logo Lights

Logo lights are located on the top of each horizontal stabilizer surface to point light on both sides of the vertical stabilizer.

Position Lights

The navigation lights are the standard red (left forward, on the inboard leading edge of the winglet), green (right forward, on the inboard leading edge of the winglet), and white (both sides of the tailcone).

Strobe Lights

Four high intensity white strobe lights are installed on the left forward winglet, right forward winglet, and both sides of the tailcone.

Anti–collision Lights

Two red anti–collision strobe lights are located on the top and bottom of the fuselage.

Wing Illumination Lights

Wing lights are installed on the fuselage and illuminate the leading edge of the wing.

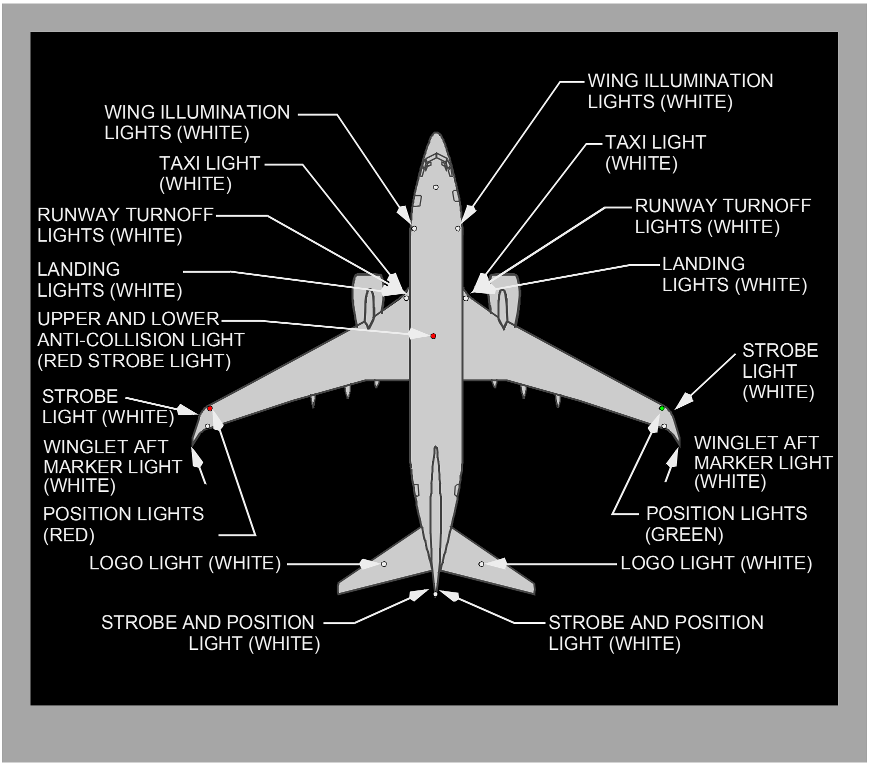
Winglet Aft Marker Lights

Winglet aft marker lights illuminate the lower portion of the winglet.

Wheel Well Lights

Lights are installed in the wheel well of the nose gear and each main gear.

Exterior Lighting Locations



Flight Deck Lighting

Flight deck lighting is provided for panel illumination, area lighting and localized illumination. Dome lights supply general flight deck flood lighting. The glareshield supplies background light for the main instrument panels. Each instrument and instrument panel has its own integral lights. Floodlights are installed for the MCP, aft electronic panel, and aft circuit breaker panel.

Map lights, chart lights and utility lights are available at the pilot stations, each with individual controls.

If normal electrical power is lost, standby electrical power is automatically provided to the standby compass light, dome lights, instrument flood lights and selected system information and warning lights.

Passenger Cabin Lighting

Passenger cabin lighting is supplied by incandescent and fluorescent lights. General cabin lighting is provided by window lights, ceiling lights, and entry lights. Reading lights are located above each passenger seat in the passenger service unit. Lights are also installed in the lavatories and galleys.

Passenger Cabin Signs

The passenger cabin signs are controlled by a switch on the forward overhead panel. With Auto selected, the signs are controlled automatically by reference to landing gear and flap positions:

FASTEN BELTS and RETURN TO SEAT signs:

- illuminate when flaps or gear are extended
- extinguish when flaps and gear are retracted.

NO SMOKING signs:

- indicate smoking is not allowed.

All passenger signs can be controlled manually by positioning the respective switch to ON or OFF.

The FASTEN BELTS and RETURN TO SEAT signs can be controlled manually by positioning the respective switch to ON or OFF. Moving the NO SMOKING switch to ON will result in a low chime sounding in the cabin.

When the passenger cabin signs illuminate or extinguish, a low tone sounds over the PA system.

Emergency Lighting

Exit lights are located throughout the passenger cabin to indicate the approved emergency exit routes. The system is controlled by a switch on the overhead panel. The switch has three positions, OFF, ARMED and ON and is guarded to the ARMED position. With the switch in the ARMED position, the emergency exit lights are normally extinguished. If electrical power to DC bus No. 1 fails or if AC power has been turned off, the emergency exit lights illuminate automatically.

The emergency exit lights may also be illuminated by a switch on the aft attendant panel. Lifting the guard and pushing the switch ON overrides the flight deck control and illuminates the emergency exit lights. Control from this panel is available in the event of failure of the automatic control.

The flight deck aft DOME light contains a separate bulb that is powered by the emergency lighting system to provide for flight deck evacuation.

Interior Emergency Lighting

Interior emergency exit lights are located:

- in the lower inboard corner of stowage bins to illuminate the aisle.
- over the entry/service and overwing emergency doors to indicate the door exits.
- in the ceiling to locate the exits and provide general illumination in the area of the exits.

Self–illuminating exit locator signs are installed at the forward, middle, and aft end of the passenger cabin.

A photoluminescent floor path marking system is installed along the cabin aisle. The photoluminescent material, when excited by light, will glow and provide exit path guidance. At the exit, electrically operated lights and markers provide exit identification.

The photoluminescent strips need to be properly charged. The table below contains charging information and can be used to determine how long the strips remain illuminated. For charging, the cabin ceiling, and sidewall lights need to be on at full intensity, and the strips should not be covered or blocked.

Sky Interior and Photoluminescent Lighting systems Standard Width and Narrow Strips (Blue or Patternmatch only)

<table>
<tr><th>First Flight of the Day with Bin Doors Closed
(White BRIGHT)</th><th>Maximum Duration Allowed (Hours)</th><th>Additional Steps to Follow for charging credit</th></tr>
<tr><td>5 minute charge</td><td>3.5</td><td rowspan="3">a) Close overhead bin doors during charging.
b) Cabin activity is limited to minor aisle traffic or crew and personnel.</td></tr>
<tr><td>10 minute charge</td><td>5</td></tr>
<tr><td>15 minute charge</td><td>7.5</td></tr>
</table>

First Flight of the Day with Bin Doors Closed (Crossbin/COS/Direct W1/W2 High)	Maximum Duration Allowed (Hours)	Additional Steps to Follow for charging credit
15 minute charge	3.5	a) Close overhead bin doors during charging. b) Cabin activity is limited to minor aisle traffic or crew and personnel. c) Passengers will shadow the system and are not allowed on board during charging.

First Flight of the Day with Bin Doors Open No Passengers (White BRIGHT)		
10 minute charge	5	a) Bin doors can be open during charging. b) Cabin activity is limited to minor aisle traffic or crew and personnel.
15 minute charge	7.5	

Quick Turn with Bin Doors Open and Passengers in Seats (White BRIGHT)		
10 minute charge	5	a) Charging must begin prior to previous discharge duration ending b) Bin doors can be open during charging c) Passenger loading and unloading periods can not be included in the charge time. Passengers can be seated on the airplane.
15 minute charge	7.5	

Quick Turn with Bin Doors Closed (Crossbin/COS/Direct W1/W2 High)		
15 minute charge	3.5	a) Close overhead bin doors during charging. b) Cabin activity is limited to minor aisle traffic or crew and personnel. c) Passengers will shadow the system and are not allowed on board during charging.

In-Flight Charging		
Taxi/Take off 10 minute charge	2.5	Charging must begin prior to previous discharge duration ending. Strips are assumed to be shadowed during meal service by galley cart and flight attendants which are stationary for 5 minutes.
Meal/Beverage 15 minute charge	3.5	
Day Cruise 15 minute charge	3.5	
Crossbin/COS/Direct W1/W2 Medium 15 minute charge	2.5	
Crossbin/COS/Direct W1/W2 High 15 minute charge	3.5	

Continuous Flight		
	No limit if ceiling and sidewall light stays on	If the Attendant Control Panel loses communication with the ceiling and sidewall lights these lights will change to a default medium white. Flight duration can be extended continuously.

Sky Interior and Photoluminescent Lighting systems with Standard Width Strips (except Blue or Patternmatch)

First Flight of the Day with Bin Doors Closed (White BRIGHT)	Maximum Duration Allowed (Hours)	Additional Steps to Follow for charging credit
5 minute charge	8	a) Close overhead bin doors during charging. b) Cabin activity is limited to minor aisle traffic or crew and personnel.
10 minute charge	9.5	
15 minute charge	12.5	

First Flight of the Day with Bin Doors Closed (Crossbin/COS/Direct W1/W2 High)	Maximum Duration Allowed (Hours)	Additional Steps to Follow for charging credit
15 minute charge	3.5	a) Close overhead bin doors during charging. b) Cabin activity is limited to minor aisle traffic or crew and personnel. c) Passengers will shadow the system and are not allowed on board during charging.

First Flight of the Day with Bin Doors Open No Passengers (White BRIGHT)		
10 minute charge	9.5	a) Close overhead bin doors during charging. b) Cabin activity is limited to minor aisle traffic or crew and personnel.
15 minute charge	12.5	

Quick Turn with Bin Doors Open and Passengers in Seats (White BRIGHT)		
10 minute charge	9.5	a) Charging must begin prior to previous discharge duration ending b) Bin doors can be open during charging c) Passenger loading and unloading periods can not be included in the charge time. Passengers can be seated on the airplane.
15 minute charge	12.5	

Quick Turn with Bin Doors Closed (Crossbin/COS/Direct W1/W2 High)		
15 minute charge	3.5	a) Close overhead bin doors during charging. b) Cabin activity is limited to minor aisle traffic or crew and personnel. c) Passengers will shadow the system and are not allowed on board during charging.

In-Flight Charging		
Taxi/Take off 10 minute charge	2.5	Charging must begin prior to previous discharge duration ending. Strips are assumed to be shadowed during meal service by galley cart and flight attendants which are stationary for 5 minutes.
Meal/Beverage 15 minute charge	3.5	
Day Cruise 15 minute charge	3.5	
Crossbin/COS/Direct W1/W2 Medium 15 minute charge	2.5	
Crossbin/COS/Direct W1/W2 High 15 minute charge	3.5	

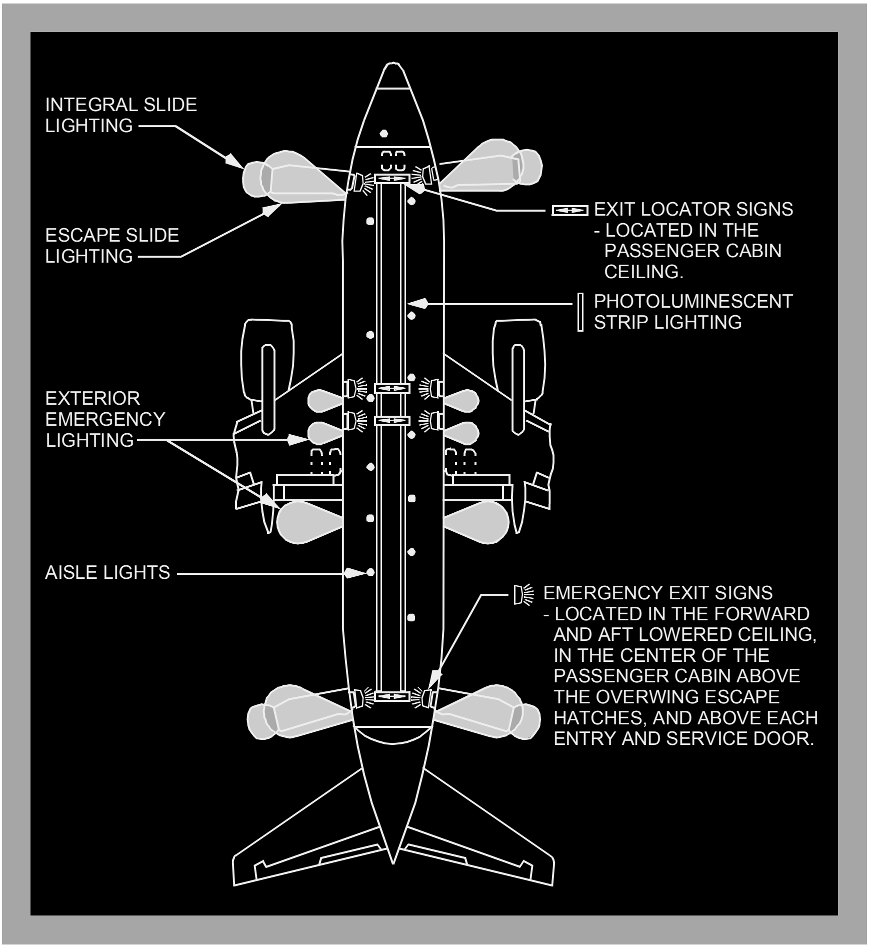
In-Flight Charging* - Double Charge at 3 Hours and 6.5 Hours		
Meal/Beverage 15 minute charge	7.5	Charging must begin prior to previous discharge duration ending. Strips are assumed to be shadowed during meal service by galley carts and flight attendants which are stationary for 5 minutes. In order to get double charging credit, strips must be charged for the first time 4 hours +/- 15 minutes after prior charge. The second charge must take place before 8 hours has elapsed from initial charge.
Day Cruise 15 minute charge	7.5	

Continuous Flight		
	No limit if ceiling and sidewall light stays on	If the Attendant Control Panel loses communication with the ceiling and sidewall lights these lights will change to a default medium white. Flight duration can be extended continuously.

Exterior Emergency Lighting

Exterior emergency lights illuminate the escape slides. The fuselage installed escape slide lights are adjacent to the forward and aft service and entry doors. Lights are also installed on the fuselage to illuminate the overwing escape routes and ground contact area.

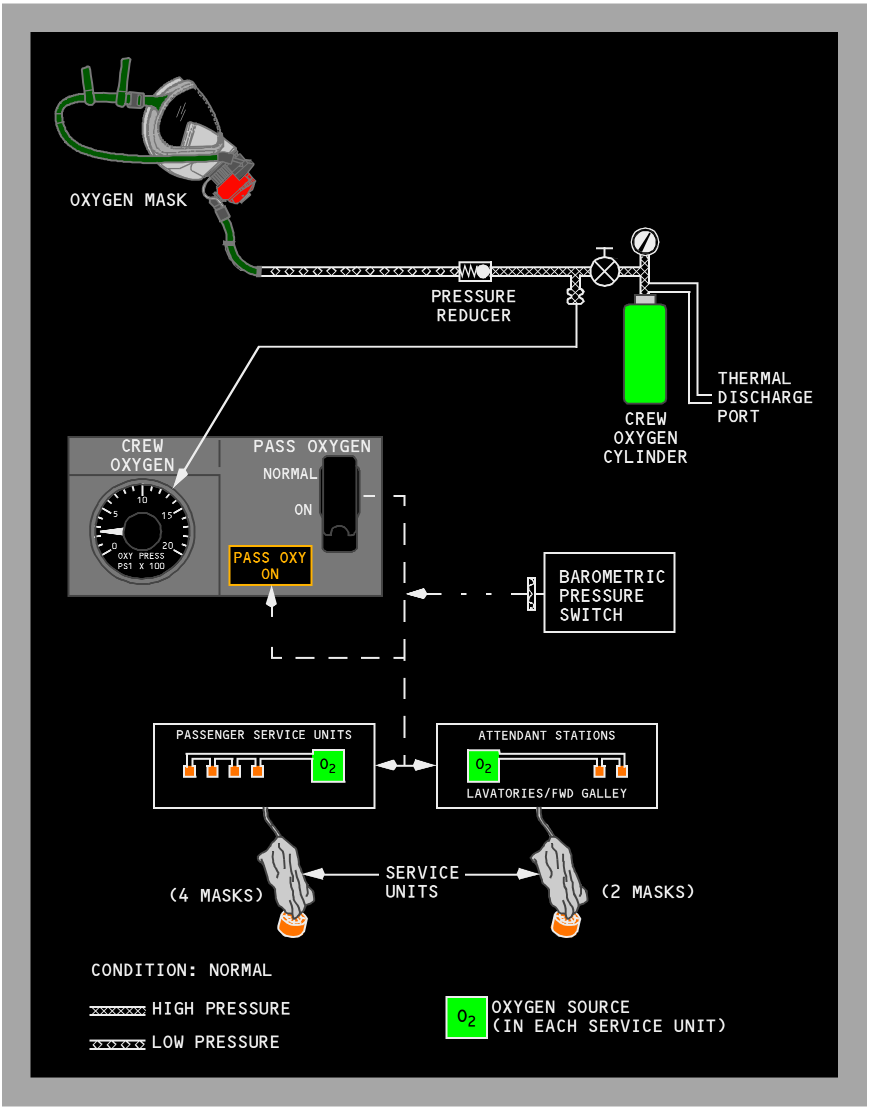
Emergency Exit Lighting



Oxygen Systems

Two independent oxygen systems are provided, one for the flight crew and one for the passengers. Portable oxygen cylinders can be located throughout the airplane for emergency use. These cylinders are normally found in the forward and aft areas of the passenger cabin.

Oxygen System Schematic



Flight Crew Oxygen System

The flight crew oxygen system uses quick-donning, diluter-demand masks/regulators located at each crew station. Oxygen is supplied by a single cylinder. Oxygen pressure is displayed on the Oxygen Pressure indicator located on the aft overhead panel when the battery switch is ON. Oxygen flow is controlled through an in-line, pressure-reducing regulator to supply low-pressure oxygen to the regulator on the mask. System pressure may be as high as 1850 psi.

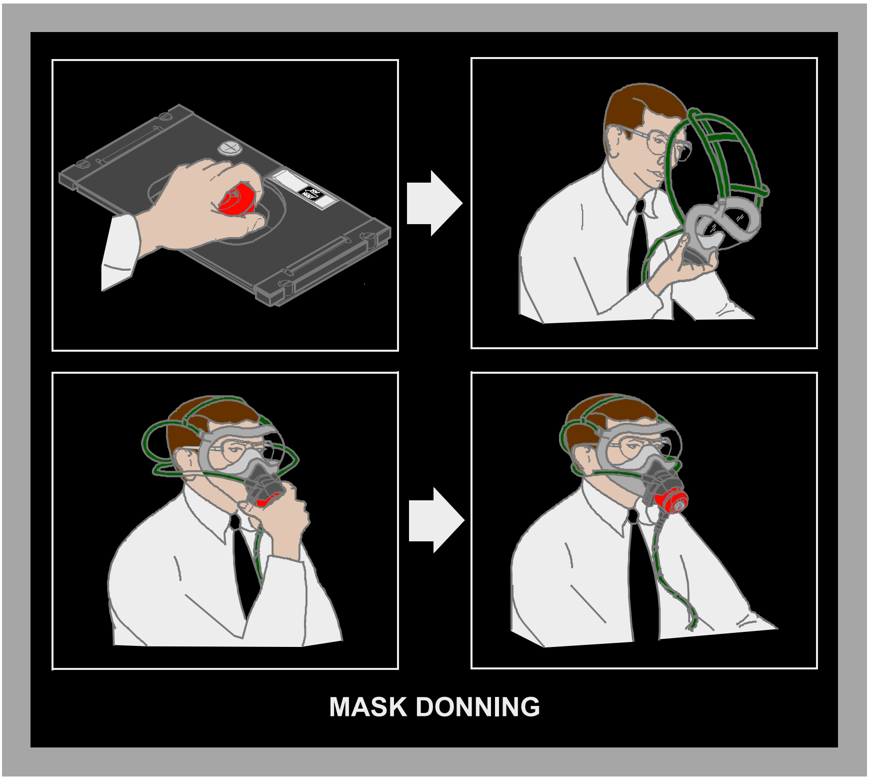
Oxygen flow is controlled by a regulator that is mounted on the oxygen mask. The regulator may be adjusted to supply NORMAL, 100% or EMERGENCY oxygen by rotating the regulator selector.

Flight Crew Oxygen Mask Usage

Donning Instructions

To don the oxygen mask accomplish the following:

- Grasp the regulator with the hand nearest the stowage box.
- Pull upward to expose the entire regulator and mask assembly.
- Squeeze the inflation lever while pulling the mask across in front of you, toward the center of the airplane (to ensure ample hose extension) and while rolling the mask face-up.
- Lean slightly toward the center of the airplane and place your face into the mask so the chin contacts the lower part of the mask first, then roll the top of the mask toward your forehead so the harness goes over and behind your head.
- Release the inflation lever so the harness holds the mask in place.



Stowing Instructions

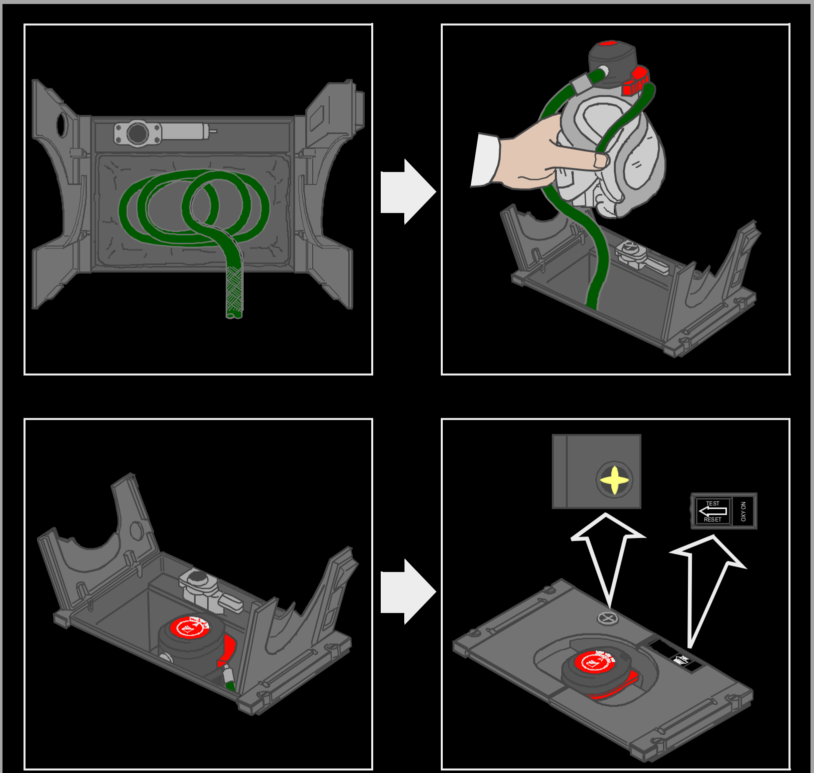
To stow the oxygen mask accomplish the following:

- Set the regulator to “100%.”
- Ensure that the cloth liner is secured at the top of the stowage box and is laying flat against all interior sides of the box.
- Coil the supply hose into the bottom of the stowage box, making the largest diameter possible.
- Ensure that the harness is completely deflated.
- Hold the mask by the regulator with the facepiece down and the inside of the mask toward you.
- Grasp the harness “cross,” then pull it downward toward the top of the facepiece and tightly roll the mask around it. Allow the excess harness to hang down from the top of the rolled facepiece.

CAUTION: Do not push the harness "cross" straps into or behind the nose piece. Doing this may cause the cross straps to hang up on the mask during inflation.

- Position the supply hose along the side of the rolled facepiece on the outboard side (relative to the aircraft).
- Insert the mask-regulator assembly into the stowage box, beginning with the harness (regulator up).
- Press down on the mask-regulator until all but the regulator control knob is below the top surface of the stowage box.
- Close the right-hand door. The "OXY ON" flag will slide into view.
- Close the left-hand door, ensuring not to pinch the hose
- Press, then release the "TEST AND RESET" control lever on the right-hand door. Ensure that the "OXY ON" flag disappears when the lever is released.

WARNING: Do not push the red Release Levers on the regulator. Doing this will inflate the harness and prevent the correct stowage of the mask-regulator.



MASK STOWING

Portable Protective Breathing Equipment

Protective Breathing Equipment (PBE/Smoke Hood) devices for crew use (for combating fires and/or entering areas of smoke or fume accumulation) may be stowed throughout the airplane; however, they are normally found in the forward and aft sections of the passenger cabin. The device is placed over the head and, when activated, provides approximately 15 to over 20 minutes of oxygen depending upon the device used. Manufacturer’s operating instructions are placarded on the container.

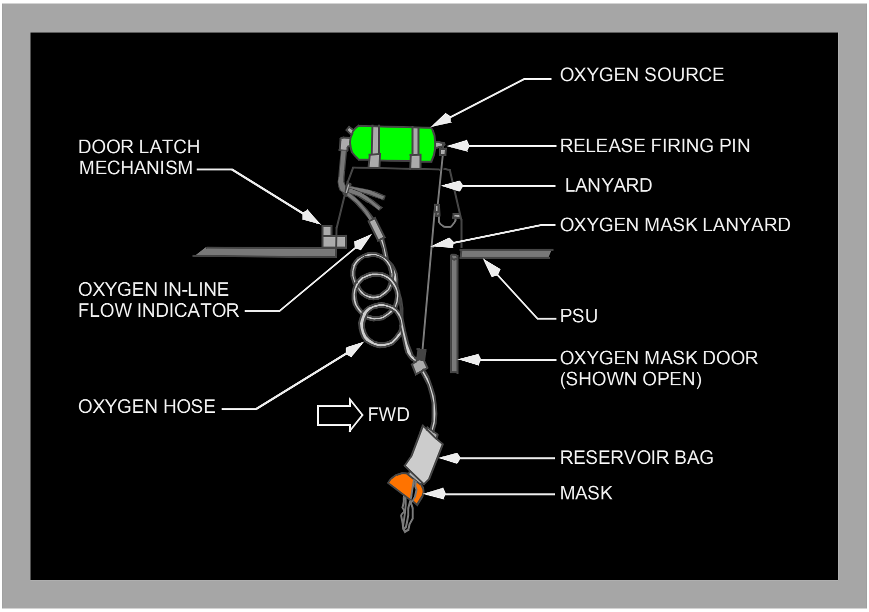
Passenger Oxygen System

The passenger oxygen system is supplied by an individual oxygen source located at each Passenger Service Unit (PSU). Four continuous flow masks are connected to each source. An oxygen source with two masks is located above each attendant station and in each lavatory.

The system is activated automatically by a pressure switch at a cabin altitude of 14,000 feet or when the Passenger Oxygen Switch on the aft overhead panel is positioned to ON. When the system is activated, the PASS OXY ON light illuminates and OVERHEAD illuminates on the Master Caution System.

Activating the system causes the masks to drop from the stowage compartments. The oxygen source is activated when any mask in the unit is pulled down. Pulling one mask down causes all masks in that unit to come down and 100% oxygen flows to all masks. A green in–line flow indicator is visible in the transparent oxygen hose whenever oxygen is flowing to the mask. Oxygen flows for approximately 12 minutes (22 minutes as installed) and cannot be shut off. If the passenger oxygen is activated and a PSU oxygen mask compartment does not open, the masks may be dropped manually.

PSU Oxygen Mask Compartment



WARNING: When using passenger oxygen, the "NO SMOKING" sign should be strictly observed. Once the oxygen source is activated, the flow of oxygen is constant, whether or not the mask is being worn.

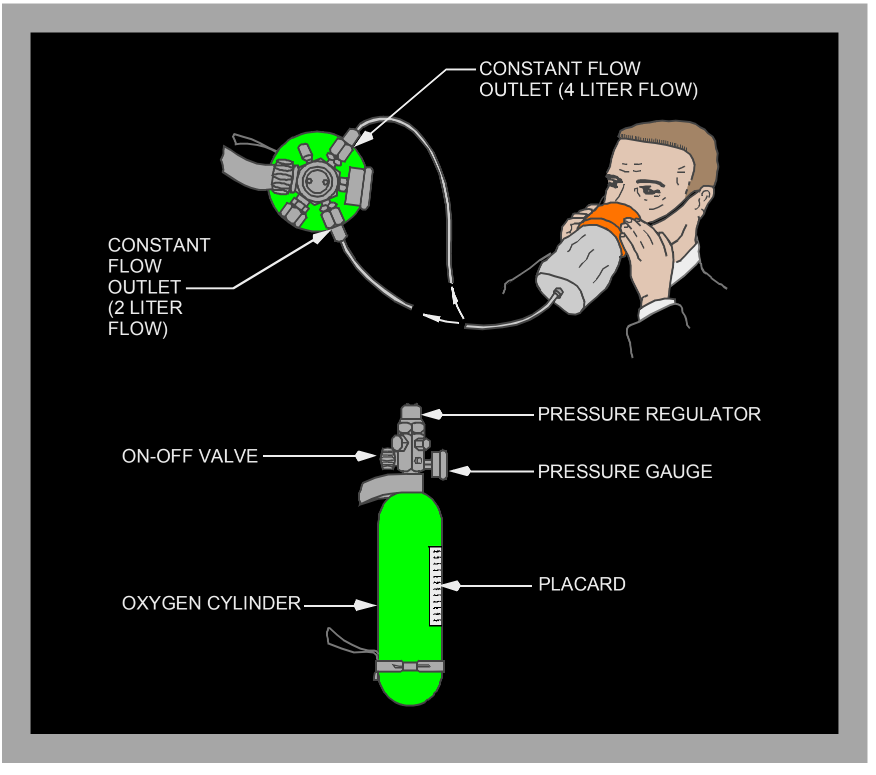
WARNING: Do not use passenger oxygen with cabin altitude below 14,000 feet when smoke or an abnormal heat source is present. The use of passenger oxygen does not prevent the passengers from inhaling smoke. Air inhaled is a mixture of oxygen and cabin air.

Passenger Portable Oxygen

First aid and supplemental portable oxygen cylinders are installed at suitable locations in the passenger cabin. The cylinders are fitted with a pressure gage, pressure regulator and on–off valve. The cylinders are pressurized to 1800 psi. At this pressure and a temperature of 70 degrees Fahrenheit, (21 degrees Celsius) the cylinders have a capacity of 4.25 cubic feet (120 liters) or 11 cubic feet (311 liters) of free oxygen. Two continuous flow outlets are provided on each cylinder, one regulates flow at two liters per minute for walk–around; the second outlet provides flow at four liters per minute. The four–liter flow is used for first aid.

Duration can be determined by dividing capacity by outflow (e. g. 120 liters divided by 4 liters/minute = 30 minutes).

Passenger Portable Oxygen Schematic



Fire Extinguishers

Fire extinguishers are located in the flight deck and passenger cabin.

Water Fire Extinguishers

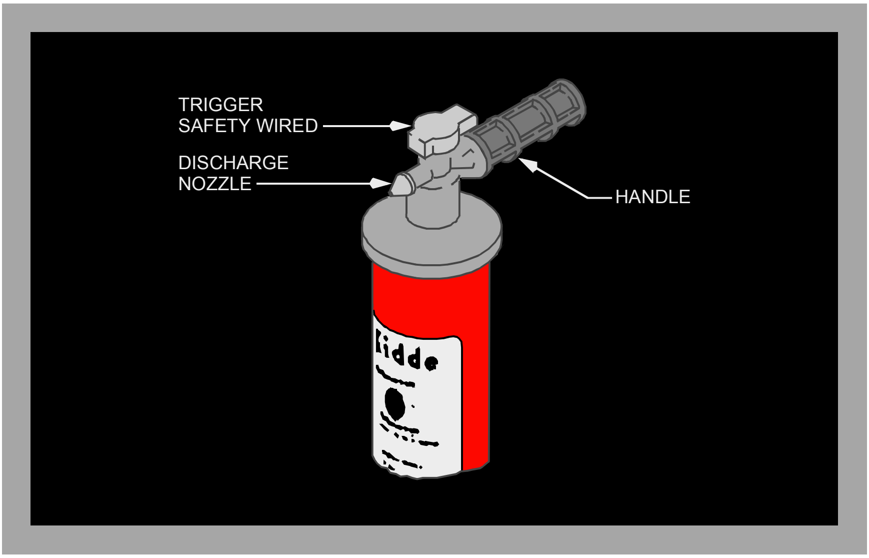
Water fire extinguishers contain a solution of water mixed with antifreeze. The container is pressurized by a CO2 cartridge when the extinguisher handle is rotated fully clockwise. The extinguisher should be used on fabric, paper or wood fires only.

To use the water fire extinguisher:

- remove from stowage
- rotate handle fully clockwise
- aim at base of fire and press trigger.

CAUTION: Do not use on electrical or grease type fires.

Water Fire Extinguisher

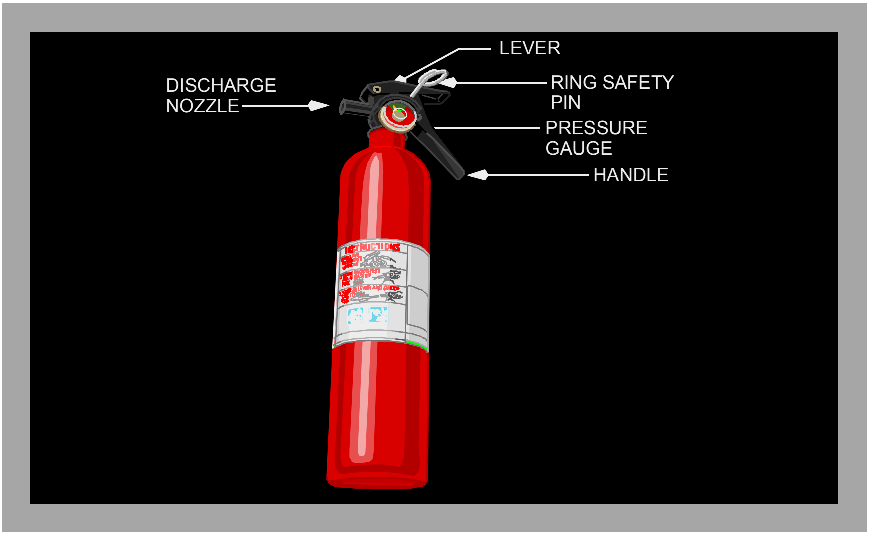


Chemical Fire Extinguishers

Chemical fire extinguishers (Halon or equivalent) contain a liquefied gas agent under pressure. The pressure indicator shows an acceptable pressure range, a recharge range, and an overcharged range. A safety pin with a pull ring prevents accidental trigger movement. When released the liquefied gas agent vaporizes and extinguishes the fire. The extinguisher is effective on all types of fires, but primarily on electrical, fuel and grease fires.

Direction for use of the fire extinguisher is printed on the extinguisher.

Chemical Fire Extinguisher (BCF/BTP)



Fire Extinguisher Usage

Each class of fire calls for specialized action. Using the wrong extinguisher may do more harm than good. For your own protection, you should know these basic types, how to use them, and why. These are the fire classification codes:

UNITED STATES CLASS OF FIRES There are three common classes of fire:		EXTINGUISHER TYPE	
CLASS A	COMBUSTIBLE MATERIALS paper, wood, fabric, rubber, certain plastics, etc., where quenching by water is effective.	TYPE A	Water (H2O) saturates material and prevents rekindling
CLASS B	FLAMMABLE LIQUIDS gasoline, oils, greases, solvents, paints, burning liquids, cooking fats, etc., where smothering action is required.	TYPE B	Halon or equivalent
CLASS C	LIVE ELECTRICAL fires started by short circuit or faulty wiring in electrical, electronic equipment or fires in motors, switches, galley equipment, etc., where a nonconducting extinguisher agent is required. NOTE: Whenever possible, electrical equipment should be de-energized before attacking a class C fire.	TYPE C	Halon or equivalent

WARNING: THE WRONG EXTINGUISHER ON A FIRE COULD DO MORE HARM THAN GOOD. FOR EXAMPLE, A B C RATED EXTINGUISHER IS NOT AS EFFECTIVE AS H2O ON A CLASS A FIRE. WATER ON FLAMMABLE LIQUID FIRES SPREAD THE FIRE. WATER ON A LIVE ELECTRICAL FIRE COULD CAUSE SEVERE SHOCK OR DEATH.

EUROPEAN/AUSTRALIAN CLASS OF FIRES There are three common classes of fire:		EXTINGUISHER TYPE	
CLASS A	COMBUSTIBLE MATERIALS paper, wood, fabric, rubber, certain plastics, etc., where quenching by water is effective.	TYPE A	Water (H2O) saturates material and prevents rekindling
CLASS B	FLAMMABLE LIQUIDS gasoline, oils, greases, solvents, paints, burning liquids, cooking fats, etc., where smothering action is required.	TYPE B	Halon or equivalent
CLASS E	LIVE ELECTRICAL fires started by short circuit or faulty wiring in electrical, electronic equipment or fires in motors, switches, galley equipment, etc., where a nonconducting extinguisher agent is required. NOTE: Whenever possible, electrical equipment should be de-energized before attacking a class C fire.	TYPE E	Halon or equivalent

WARNING: THE WRONG EXTINGUISHER ON A FIRE COULD DO MORE HARM THAN GOOD. FOR EXAMPLE, A B E RATED EXTINGUISHER IS NOT AS EFFECTIVE AS H2O ON A CLASS A FIRE. WATER ON FLAMMABLE LIQUID FIRES SPREAD THE FIRE. WATER ON A LIVE ELECTRICAL FIRE COULD CAUSE SEVERE SHOCK OR DEATH.

WARNING: If a Halon bottle or equivalent fire extinguisher is to be discharged on the flight deck, all crewmembers in the flight deck must wear oxygen masks and use 100% oxygen with emergency selected.

WARNING: The concentrated agent, and the by-products created by the heat of the fire, are toxic. Unprotected exposure to high concentrations of agent or by-products can result in dizziness, difficulty breathing, as well as eye and nose irritation. After discharge of an entire fire extinguisher, it can take up to 7 minutes for agent to dissipate. Signs of smoke should be clear and agent dissipated before removal of oxygen masks or protective breathing equipment.

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Emergency Equipment Symbols

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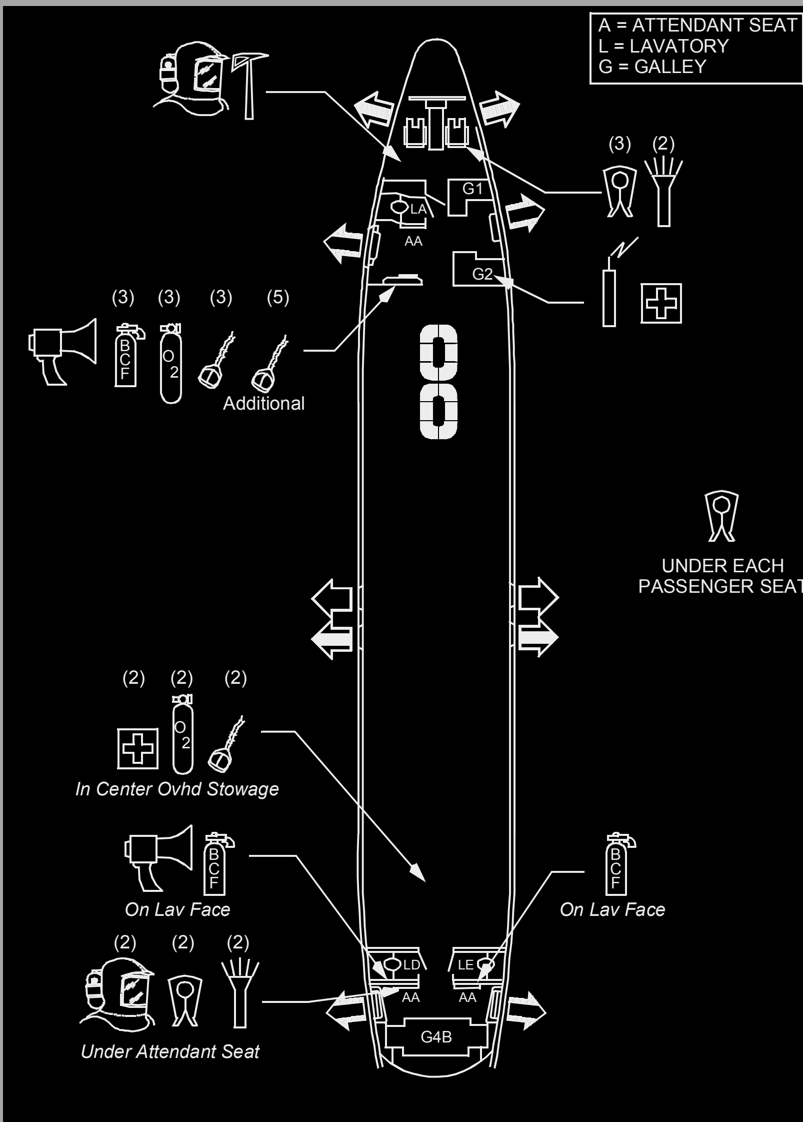
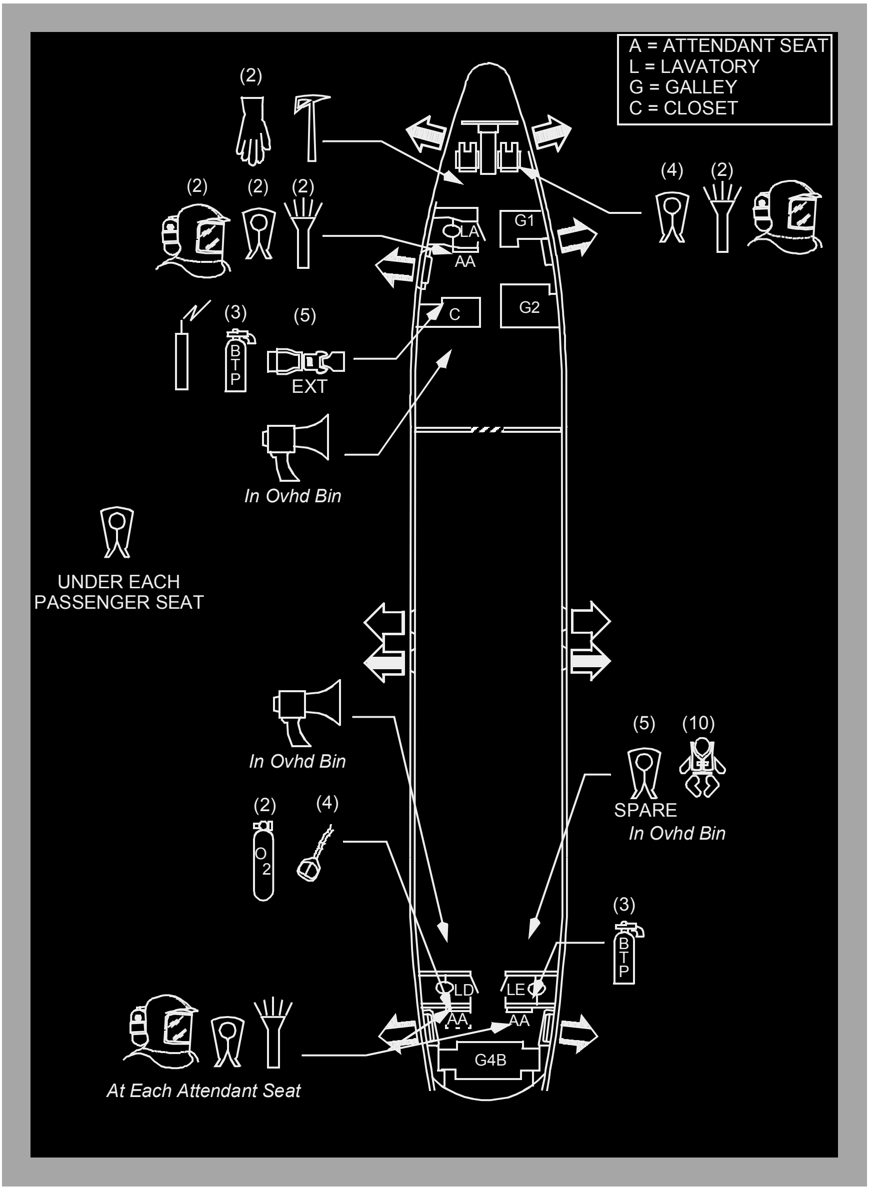
Emergency Equipment Locations – 737-8 Series Airplanes




A = ATTENDANT SEAT
L = LAVATORY
G = GALLEY
C = CLOSET
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UNDER EACH PASSENGER SEAT
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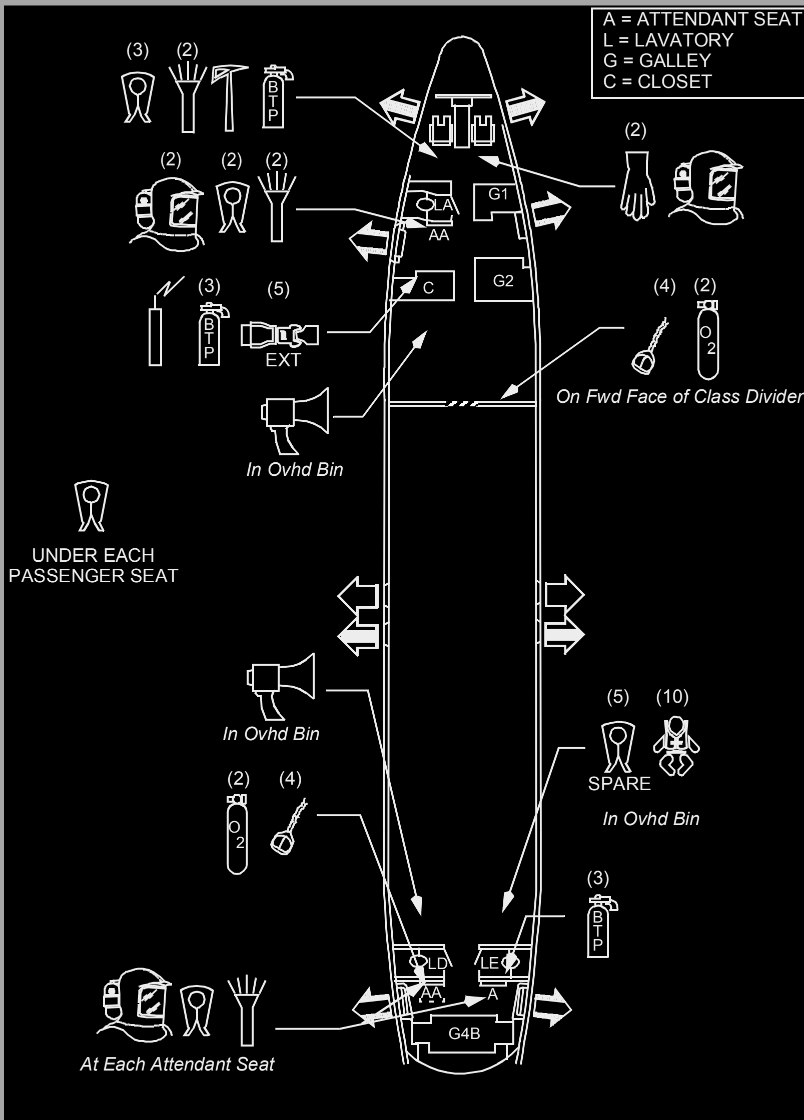
At Each Attendant Seat


A = ATTENDANT SEAT
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UNDER EACH PASSENGER SEAT
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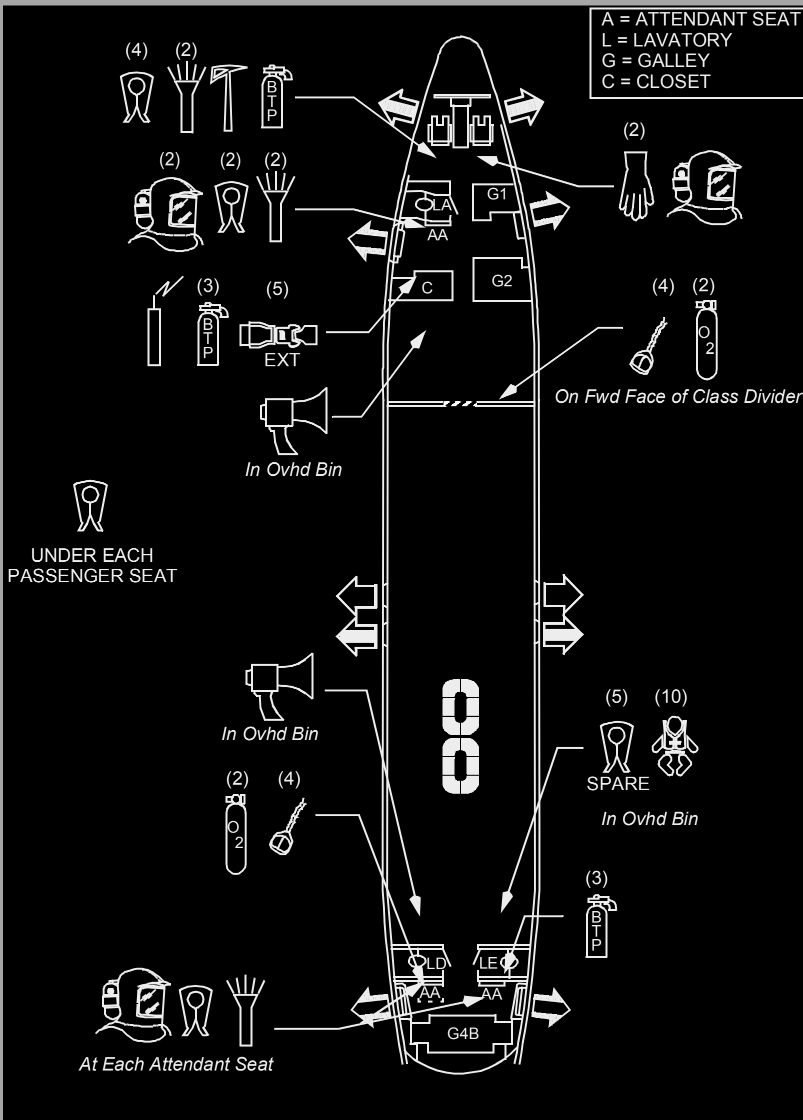
At Each Attendant Seat


A = ATTENDANT SEAT
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On Fwd Face of Class Divider
In Ovhd Bin
UNDER EACH PASSENGER SEAT
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AA
AA
G4B
At Each Attendant Seat

Doors and Windows

The airplane has two passenger entry doors, one cabin door (the flight deck/passenger cabin entry), two service doors and two cargo doors. There is also a center electrical and electronic (E/E) equipment access door and an equipment compartment access door on the bottom of the airplane.

The flight deck number two windows, one on the left and one on the right, can be opened by the flight crew.

CAUTION: Do not operate the entry or service doors with winds at the door of more than 40 knots. Do not keep the entry or service doors open when wind gusts are more than 65 knots. Strong winds can cause damage to the structure of the airplane.

Flight Deck Door

The flight deck door meets requirements for resistance to ballistic penetration and intruder entrance. The door opens into the passenger cabin. When closed, the door locks when electrical power is available and unlocks when electrical power is removed. A viewing lens in the door allows observation of the passenger cabin. The door can be manually opened from the flight deck by turning the door handle.

The door incorporates a deadbolt with a key lock on the passenger cabin side. Rotating both concentric deadbolt levers to the locked (horizontal) position prevents the passenger cabin key from unlocking the door. Rotating only the forward deadbolt lever to locked allows the key to unlock the door.

The flight deck access system consists of an emergency access panel, chime module, three position Door Lock selector, two indicator lights, and an Access System switch. The emergency access panel includes a six button keypad for entering the numeric emergency access code along with red, amber, and green lights. The red light illuminates to indicate the door is locked. When the correct emergency access code is entered, the amber light illuminates. The green light illuminates to indicate the door is unlocked.

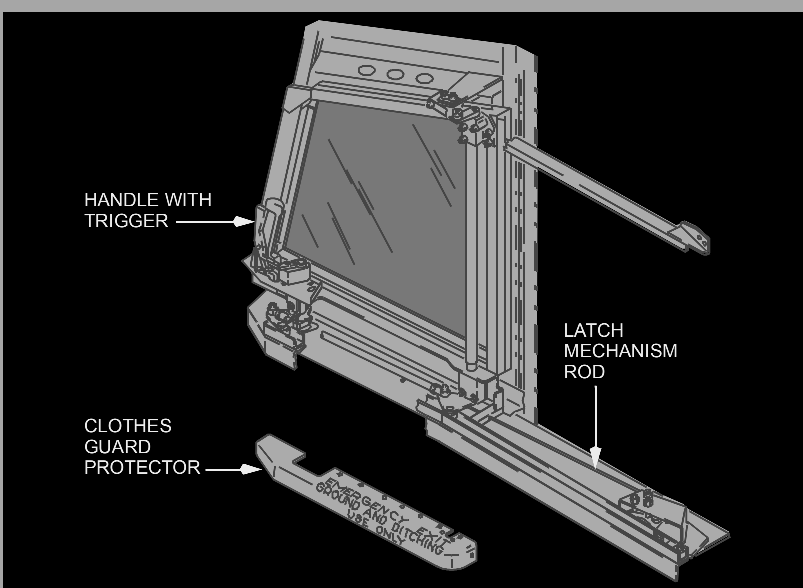
Two indicator lights and a three position Door Lock selector are located on the aft electronic panel. Illumination of the amber LOCK FAIL light indicates the door lock has failed or the Access System switch is in the OFF position.

The emergency access code is used to gain access to the flight deck in case of pilot incapacitation. A flight deck chime and illumination of the amber AUTO UNLK light indicates the correct emergency access code has been entered and the door is programmed to unlock after a time delay. Selecting the DENY position on the Door Lock selector denies entry and prevents further keypad entry for several minutes. To allow entry, the selector is turned to the UNLKD position which unlocks the door while held in that position. If the emergency access code is entered and the pilot takes no action, the door unlocks after expiration of the time delay. Before the door unlocks, the chime sounds continuously and the AUTO UNLK light flashes.

By pressing "1" then "ENT" keys on the emergency access panel, the flight deck chime will sound (if programmed).

The door incorporates two pressure sensors that unlock the decompression panels in the event pressurization is lost. The decompression panels have manual release pins. Pulling the pins frees the panels allowing egress in the event the door is jammed.

Flight Deck Number Two Windows



FLIGHT COMPARTMENT WINDOW NO. 2
(RIGHT SIDE SHOWN)

The flight deck number two windows can be opened on the ground or in flight and can be used for emergency evacuation. To open the window, depress the trigger and turn the handle back and inboard. After the window moves inboard, move it back until it locks in the open position.

To close the window, it must first be unlocked. Pull forward on the latch mechanism rod to unlock the window. Depress the trigger and move the window forward until the handle can be turned forward and outboard. When the trigger is released, the window latches.

Only the first officer's number two window can be opened from outside the airplane.

Lower Cargo Compartments

The lower cargo compartments are designed and constructed to satisfy FAA category Class C compartment requirements. This means the compartments are designed to completely confine a fire without endangering the safety of the airplane or its occupants. The compartments are sealed and pressurized but do not have fresh air circulation and temperature control as do the upper passenger compartments.

There are two cargo compartment doors on the lower right side of the fuselage. Both are plug type, inward opening pressure doors, hinged at their upper edges and operated manually from either inside or outside the airplane. Except for slight difference in shape, both doors are similar in design and operation. The door is locked closed by two latches. Each door has a balance mechanism which creates door–open force slightly more than equal to the weight of the door. The door can therefore, with little effort, be swung open. The door can be closed easily by pulling a lanyard attached to the door, grasping the handle and closing the door.

A pressure equalization valve is in the aft bulkhead of each compartment. The valves let only enough air flow into or out of the cargo compartments to keep the pressures nearly the same as the cabin pressure.

Blowout panels in the lower cargo compartments provide pressure relief at a greater rate than the pressure equalization valve in case the airplane pressurization is lost.

Emergency Escape

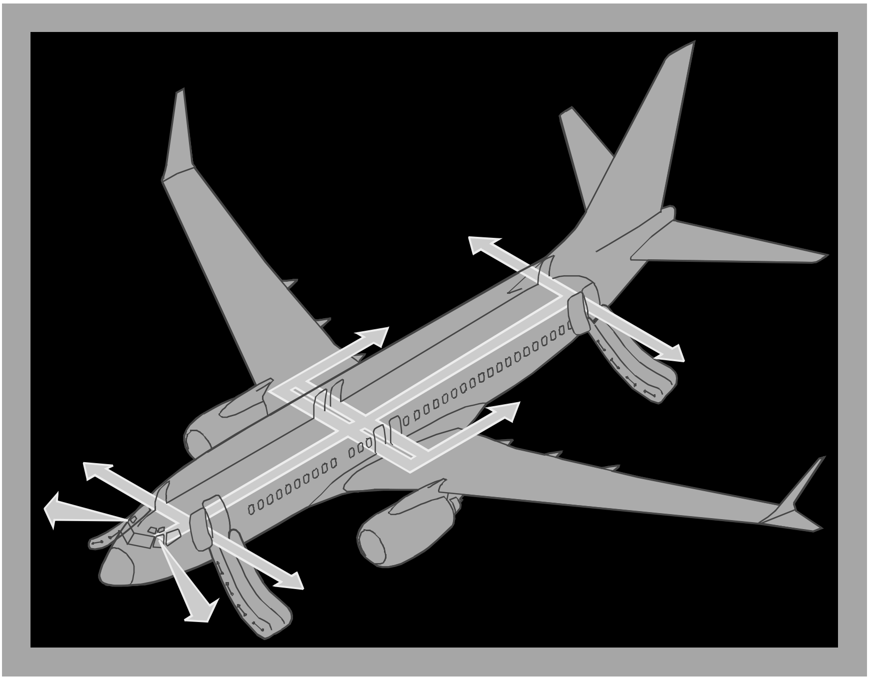
Emergency escape information included in this chapter includes:

- emergency evacuation routes
- flight deck windows
- escape slides
- escape straps
- emergency exit doors

Emergency Evacuation Routes

Emergency evacuation may be accomplished through four entry/service doors and four overwing escape hatches. Flight deck crew members may evacuate the airplane through two sliding flight deck windows.

Emergency Evacuation Routes

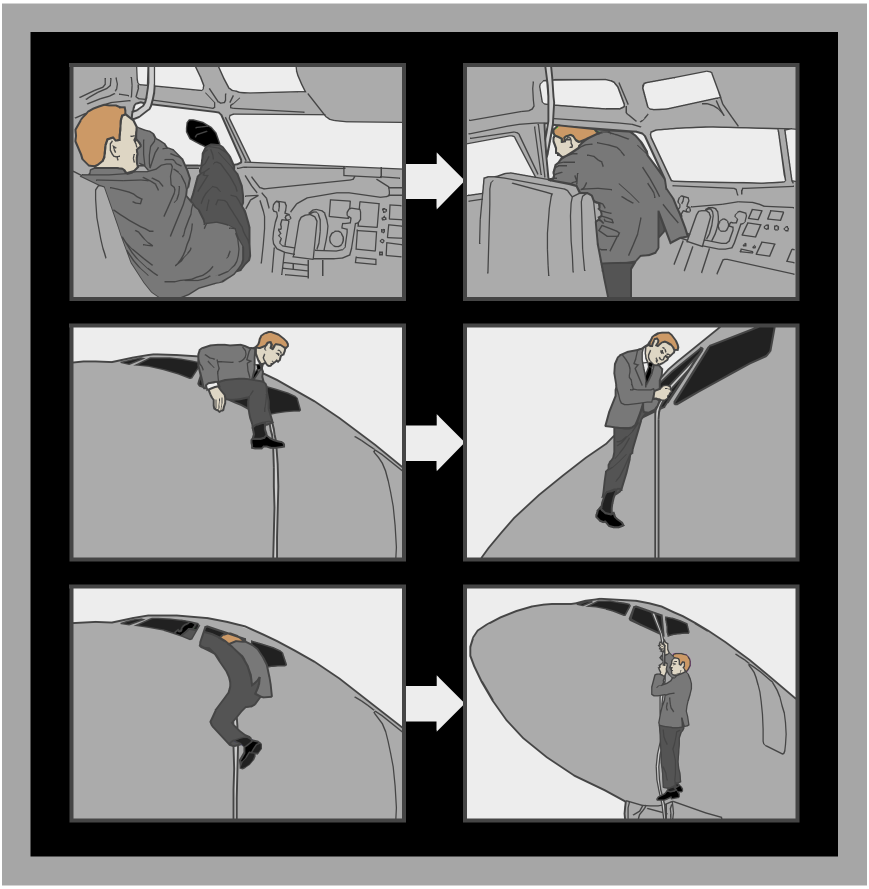


Flight Deck Window Emergency Egress

If the flight deck number two windows must be used for emergency egress, use the following procedure:

- open the window
- open the escape strap compartment (above and aft of window)
- pull on the escape strap to ensure it is securely attached
- throw the strap out the window
- sit on the window sill with upper body outside
- exit in accordance with the following illustration.

CAUTION: Ensure the escape strap is securely fastened to the airplane.

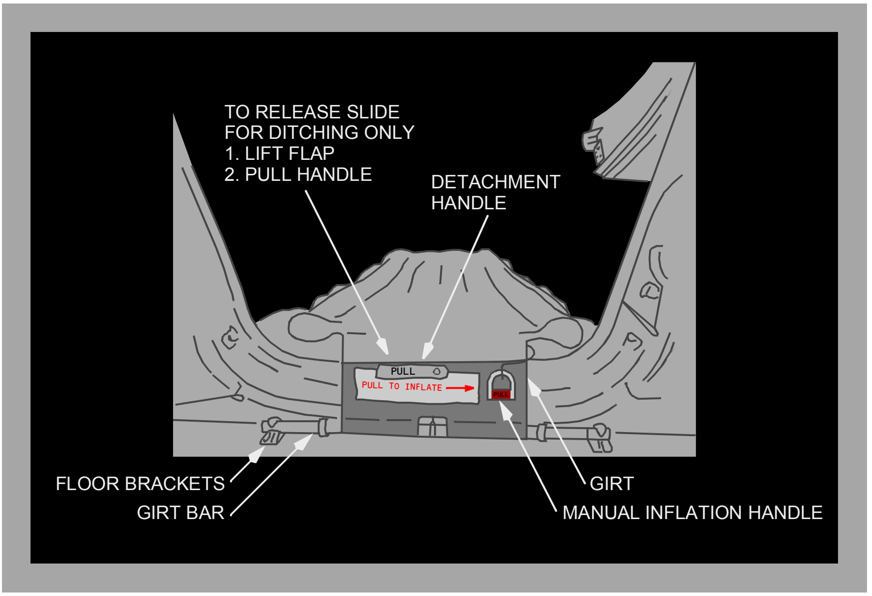


The above illustrated method of departure would probably be the easiest for most crewmembers. This technique is difficult and should be used only in extreme emergency.

Escape Slide Detachment Handle

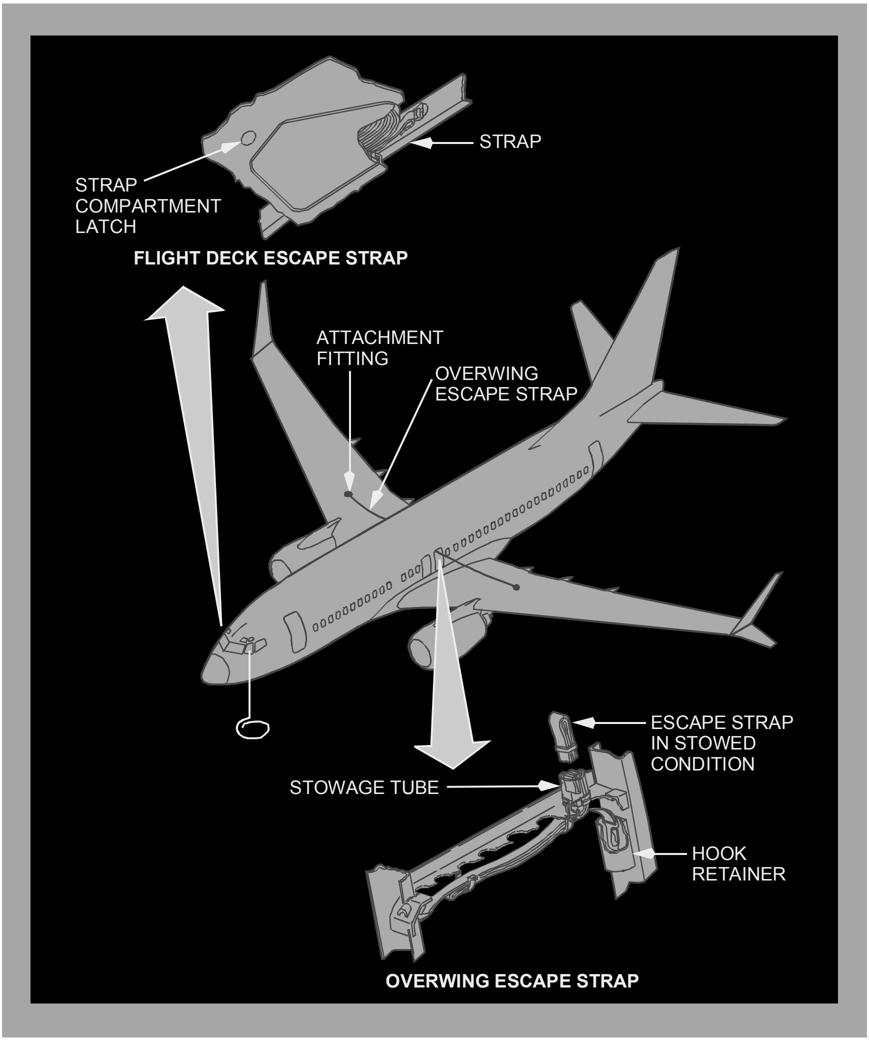
The slide has not been certified to be part of the water landing emergency equipment. In a water environment, the slide may not properly inflate when deployed. If the deployed slide is recognized to be a potential obstruction to egress, a detachment handle is provided near the top of the slide. This handle is protected by a cover and is placarded. The escape slide is detached from the airplane by pulling the detachment handle. Once detached from the door sill, the slide is tethered to the door sill by a lanyard. A properly inflated slide could be buoyant, and useful as a flotation device for passengers in the water. Hand grips are positioned along the sides of the slide.

Escape Slide Detachment Handle



Escape Straps

Escape straps are installed above each aft emergency exit door frame. The escape doors must be opened to expose the straps. One end of the strap is attached to the door frame. The remainder of the strap is stowed in a tube extending into the cabin ceiling. To use, the strap is pulled free from its stowage and attached to a ring on the top surface of the wing. The escape strap can be used as a hand hold in a ditching emergency for passengers to walk out on the wing and step into a life raft.



Emergency Exit Doors

Four Type III emergency exits are located in the passenger cabin over the wings. These are canopy-type doors and are held in place by mechanical locks and airplane cabin pressure.

The overwing exit doors can be opened from inside or outside of the airplane by a spring–loaded handle at the top of the door. The 28 Volt DC flight lock system is designed to ensure that the flight lock will automatically lock during takeoff, in-flight, and landing and unlock on the ground to allow for opening of the door in emergency situations. Commands for the flight lock to lock and unlock are dependent upon engine speed, thrust lever position, air/ground mode status, and the open/closed status of the doors.

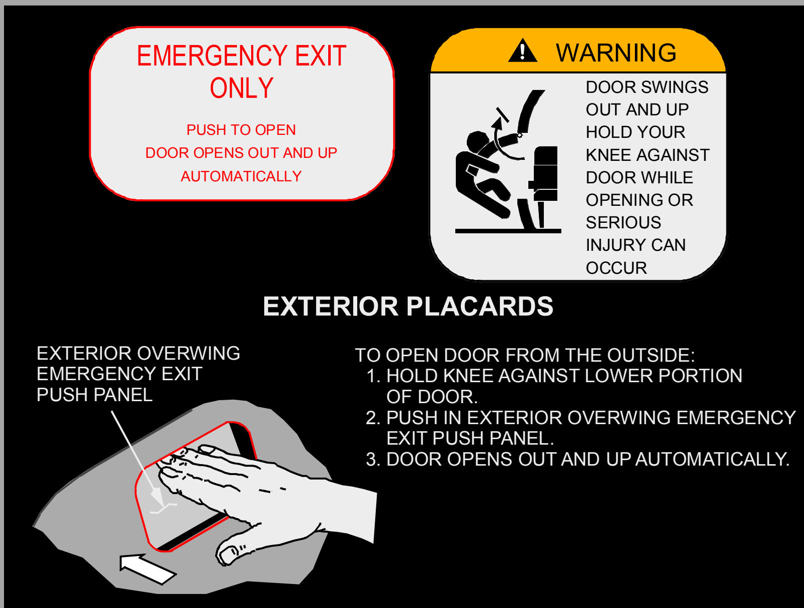
The overwing emergency exits lock when:

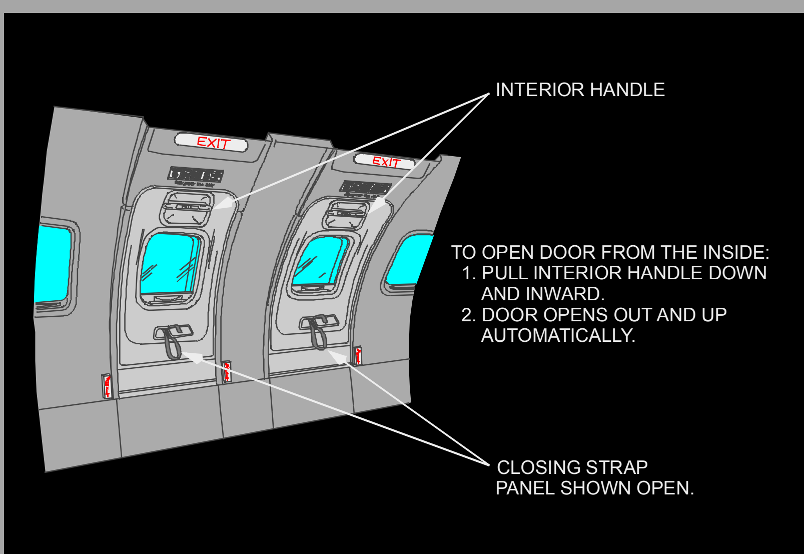
- three of the four Entry/Service doors are closed and
- either engine is running and
- the airplane air/ground logic indicates that the airplane is in the air or both thrust levers are advanced.

The overwing emergency exits unlock when any one of the above conditions is not met or DC power is lost.

The LEFT OVERWING and/or RIGHT OVERWING warning lights, DOORS annunciator, and MASTER CAUTION light illuminate when an emergency exit door is not fully closed and locked or when the flight lock is not engaged, either during the takeoff roll or in-flight.

If a flight lock has failed locked or a fault is detected the MAINT light, the OVERHEAD annunciator, and the MASTER CAUTION lights illuminate. These indications are inhibited from the first engine start until 30 seconds after landing. When the doors are latched and locked and the flight lock is operating properly none of these lights will illuminate.


EMERGENCY EXIT ONLY
PUSH TO OPEN
DOOR OPENS OUT AND UP AUTOMATICALLY
WARNING
DOOR SWINGS OUT AND UP HOLD YOUR KNEE AGAINST DOOR WHILE OPENING OR SERIOUS INJURY CAN OCCUR
EXTERIOR PLACARDS
EXTERIOR OVERWING EMERGENCY EXIT PUSH PANEL
TO OPEN DOOR FROM THE OUTSIDE:
1. HOLD KNEE AGAINST LOWER PORTION OF DOOR.
2. PUSH IN EXTERIOR OVERWING EMERGENCY EXIT PUSH PANEL.
3. DOOR OPENS OUT AND UP AUTOMATICALLY.


INTERIOR HANDLE
EXIT
EXIT
TO OPEN DOOR FROM THE INSIDE:
1. PULL INTERIOR HANDLE DOWN AND INWARD.
2. DOOR OPENS OUT AND UP AUTOMATICALLY.
CLOSING STRAP
PANEL SHOWN OPEN.

Flight Deck Seats

The flight deck has three seat types:

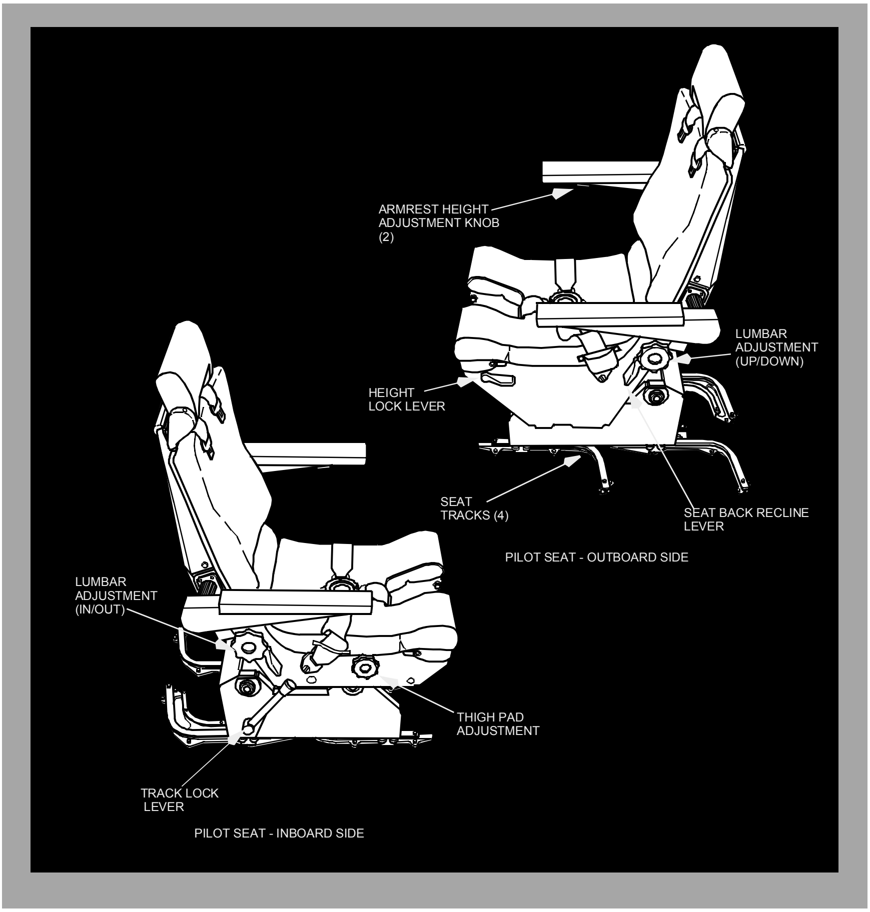
- pilot seats (captain and first officer)
- first observer seat
- second observer seat (as installed)

Pilot Seat

The captain and first officer seats are adjustable. The following controls are provided:

- Seat height
- Thigh pad position
- Seat recline
- Armrest height and stowage
- Back cushion (lumbar support) position
- Headrest position

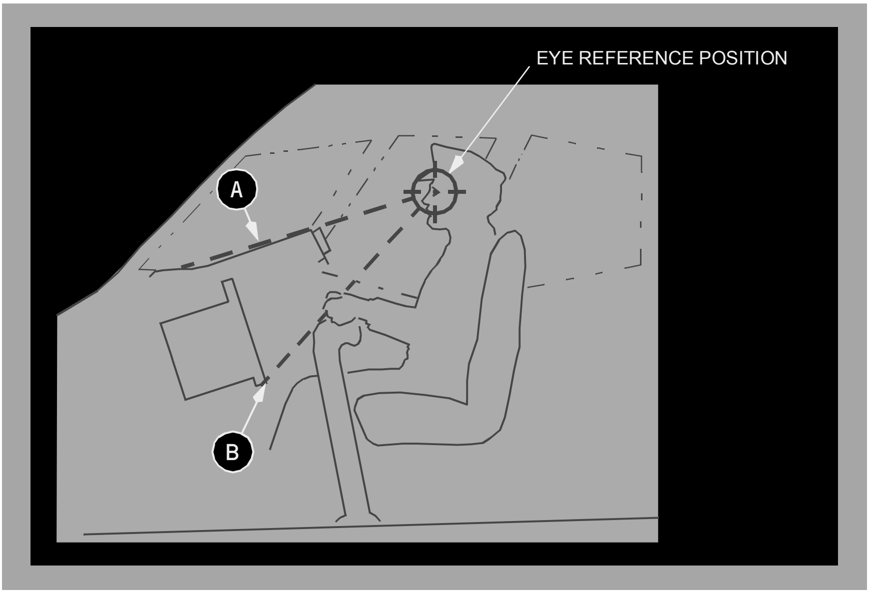
Four units hold the base of the seat to the aircraft seat tracks. A spring-loaded track lock lever mechanism sets fore and aft movement on the seat tracks.



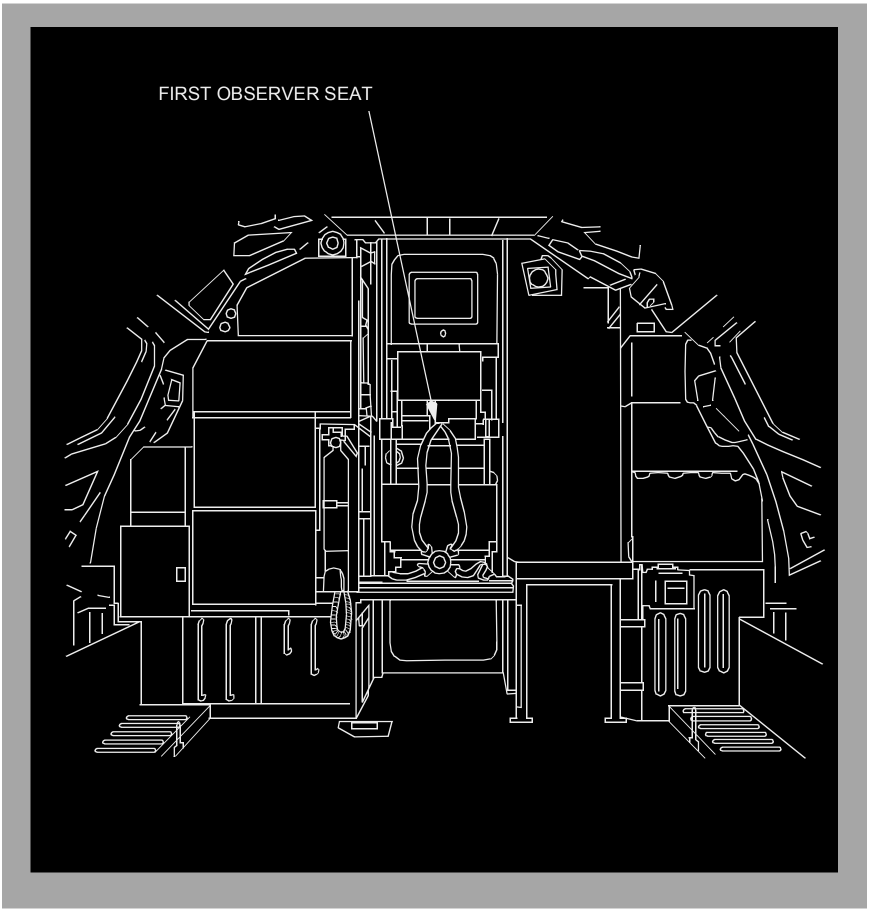
Pilot Seat Adjustment

Adjust the seat position with the appropriate controls to obtain the optimum eye reference position. Use the handhold above the forward window to assist. The following sight references are used:

- Sight along the upper surface of the glareshield with a small amount of the airplane nose structure visible (A)
- Sight over the control column (in the neutral position) until the bottom edge of the outboard display unit is visible (B).


EYE REFERENCE POSITION
A
B

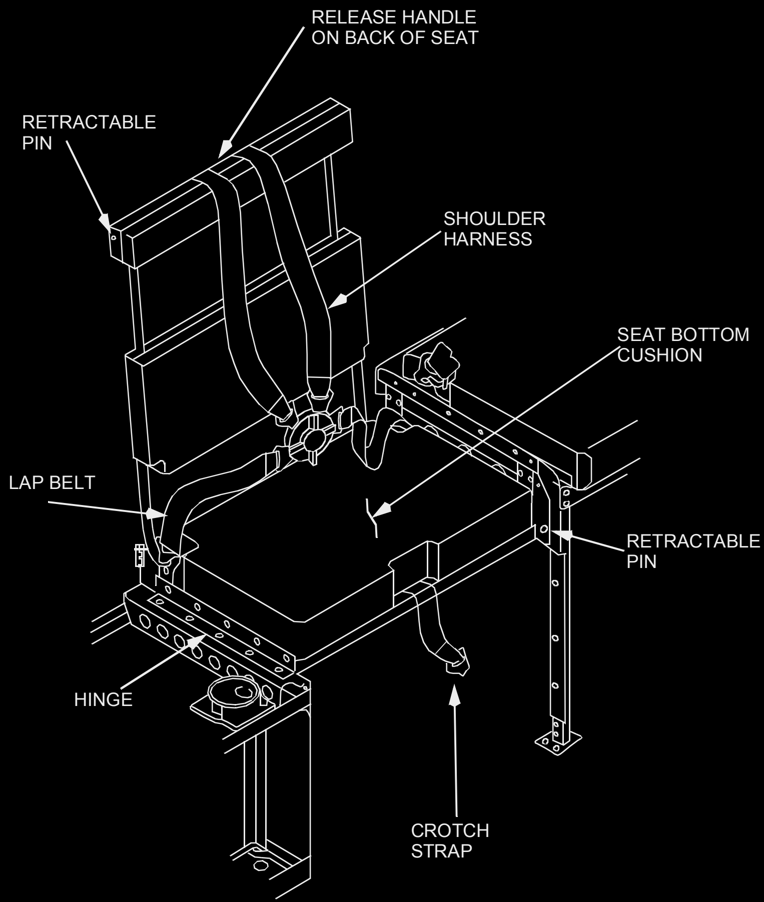
First Observer Seat



The first observer seat folds into the flight compartment wall when not in use. To use the seat, push the release latch. Then lower the seat into position. Raise the seat back to the detents in the doorway sidewall brackets. For seat storage, push the release on the seat back and reverse the procedure. The seat bottom cushion is an approved flotation device.

The seat has:

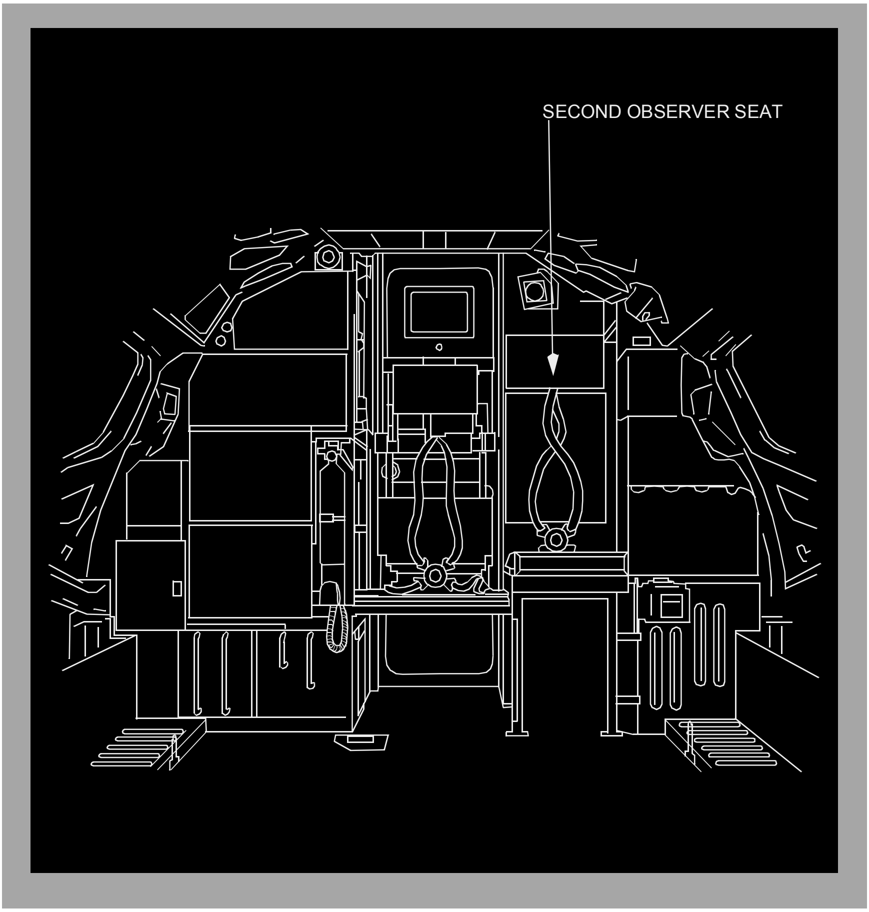
- shoulder harness
- crotch strap
- lap belt
- seat bottom cushion



NOTE:

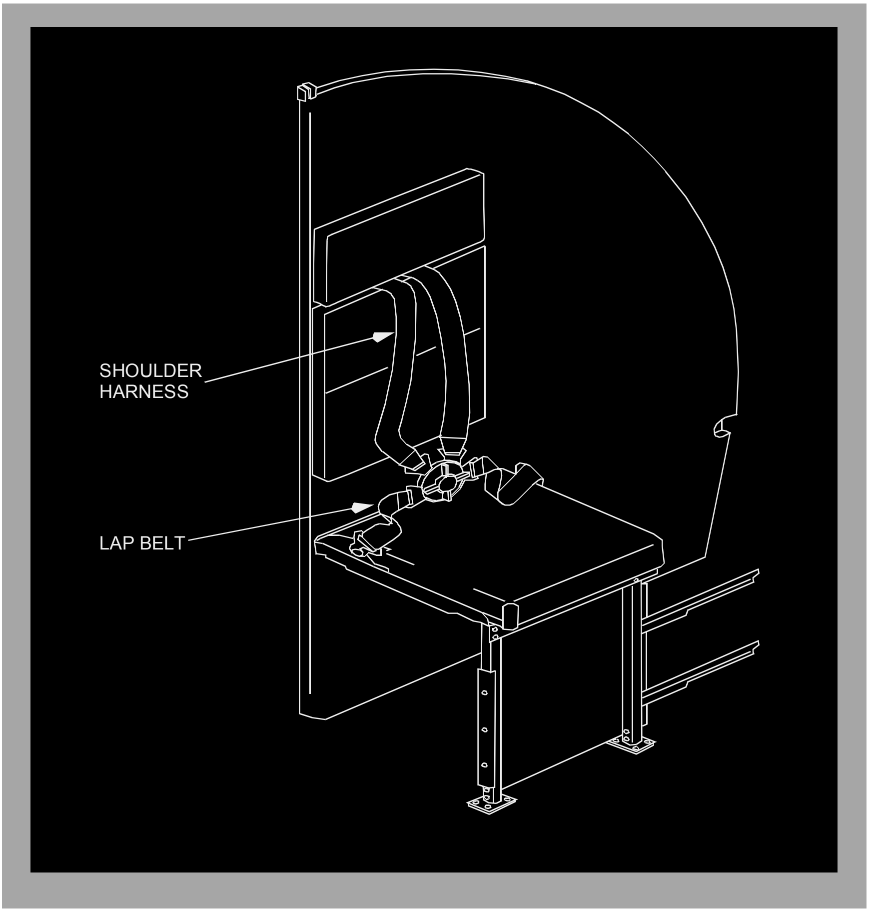
THE SEAT FOLDS INTO THE WALL WITH VERY CLOSE TOLERANCES.
USE CAUTION NOT TO PINCH YOUR FINGERS WHEN YOU STOW THE SEAT.

Second Observer Seat



The second observer seat is located behind the captain's seat and is not adjustable. The seat has:

- shoulder harness
- lap belt



Galleys

Galleys are located in the passenger cabin to provide convenient and rapid service to the passengers. Generally, they are installed in the cabin adjacent to the forward and aft galley service doors.

In general the equipment of the galley unit consists of the following main items:

- high speed ovens
- hot beverage containers
- hot cup receptacles
- refrigeration and main storage compartments.

Electrical control panel switches and circuit breakers to operate the above equipment are conveniently located within the galley work area. Storage space, miscellaneous drawers and waste containers are also integrated in the galley units.

Electrical Power

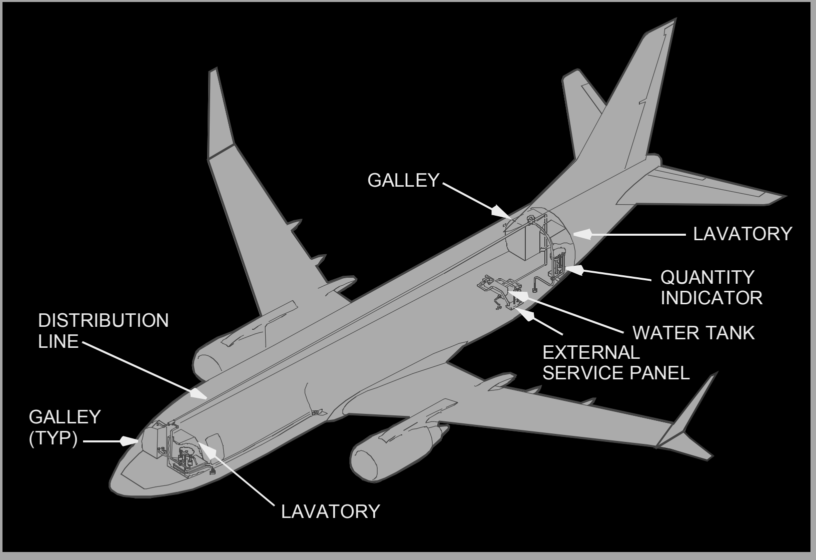
Electricity for the galleys is 115V AC supplied from the airplane transfer buses and controlled by a switch on the overhead panel. Circuit breakers are located in the lower E/E bay as part of the power distribution panels.

Water Service

Water is supplied to the galleys from the airplane pressurized water system and, in an emergency, may be shut off at the galley.

Water System

The potable airplane water system is supplied from a single tank located behind the aft cargo compartment. Fresh water is supplied to the galleys and lavatory sinks.



WATER SYSTEM

Quantity Indication and System Operation

A quantity indicator is located on the attendant panel. The system is pressurized by engine bleed air or by the water system air compressor. Shutoff valves are located on each galley and below the sink in each lavatory. The drain position of this valve is used to drain all water overboard. Normally, the drain shutoff valves are ON.

Hot Water

Hot and cold water is available in all lavatories. The water heater is located below the lavatory sink. When emptied, it heats a new water charge in four minutes. An amber light is ON when the heater is operating normally. The heater has an overheat switch which turns off the heating element if an excess temperature is reached. The heater may be turned off at any time by using a manual switch on the heater. Cold water is supplied at the galleys.

Servicing

The system is serviced from an exterior panel located on the bottom right side of the aft fuselage. Pressure filling is required. Waste water from the galleys and lavatory wash basins is drained overboard through two heated drain masts. The drain mast are on the bottom of the fuselage; one forward and one aft.

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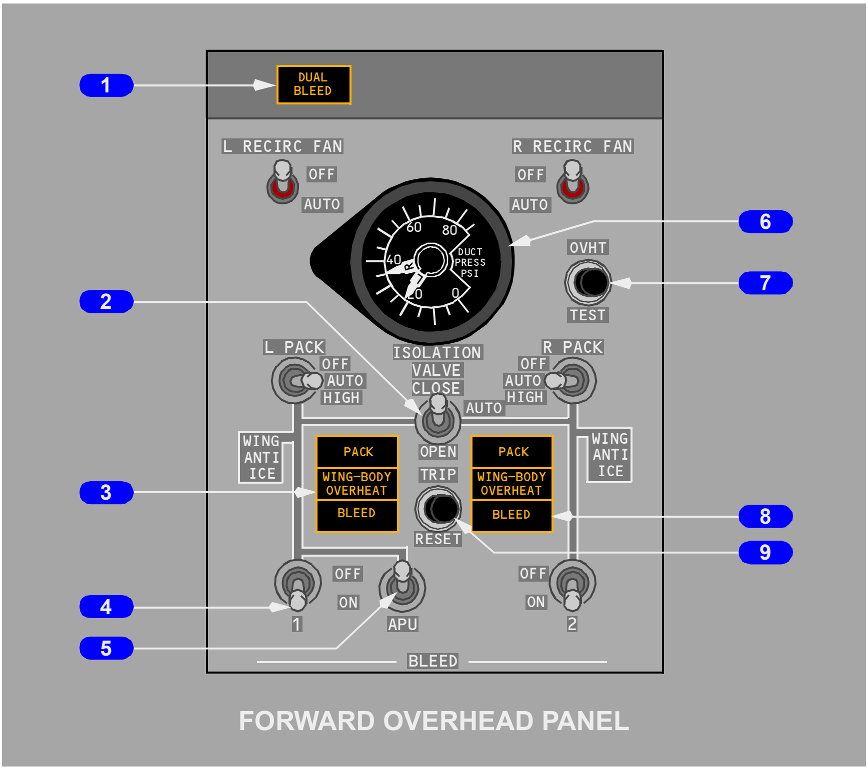
Bleed Air Controls and Indicators



1 DUAL BLEED Light

Illuminated (amber) – APU bleed air valve open and engine No. 1 BLEED air switch ON, or engine No. 2 BLEED air switch ON, APU bleed air valve and isolation valve open.

2 ISOLATION VALVE Switch

CLOSE – closes isolation valve.

AUTO –

- closes isolation valve if both engine BLEED air switches are ON and both air conditioning PACK switches are AUTO or HIGH
- opens isolation valve automatically if either engine BLEED air or air conditioning PACK switch positioned OFF.

OPEN – opens isolation valve.

3 WING–BODY OVERHEAT Light

Illuminated (amber) –

- left light indicates overheat from bleed air duct leak in left engine strut, left inboard wing leading edge, left air conditioning bay, keel beam or APU bleed air duct
- right light indicates overheat from bleed air duct leak in right engine strut, right inboard wing leading edge or right air conditioning bay.

4 Engine BLEED Air Switches

OFF – closes engine bleed air valve.

ON – opens engine bleed air valve when engines are operating.

5 APU BLEED Air Switch

OFF – closes APU bleed air valve.

ON – opens APU bleed air valve when APU is operating.

6 Bleed Air DUCT PRESSURE Indicator

Indicates pressure in L and R (left and right) bleed air ducts.

7 Wing–Body Overheat (OVHT) TEST Switch

Push –

- tests wing–body overheat detector circuits
- illuminates both WING–BODY OVERHEAT lights
- illuminates both MASTER CAUTION lights
- illuminates AIR COND light

8 BLEED Light

Illuminated (amber) – excessive engine bleed air temperature, over-pressure or under-pressure

- related engine bleed air valve closes automatically
- requires reset.

OR

Illuminated (amber) – a failure within the bleed air system

- bleed system failure may not be resettable

OR

Illuminated (amber) – an incorrect bleed air configuration after takeoff or go-around

- turning either BLEED switch ON will extinguish both BLEED lights if lights illuminated because of a configuration problem.

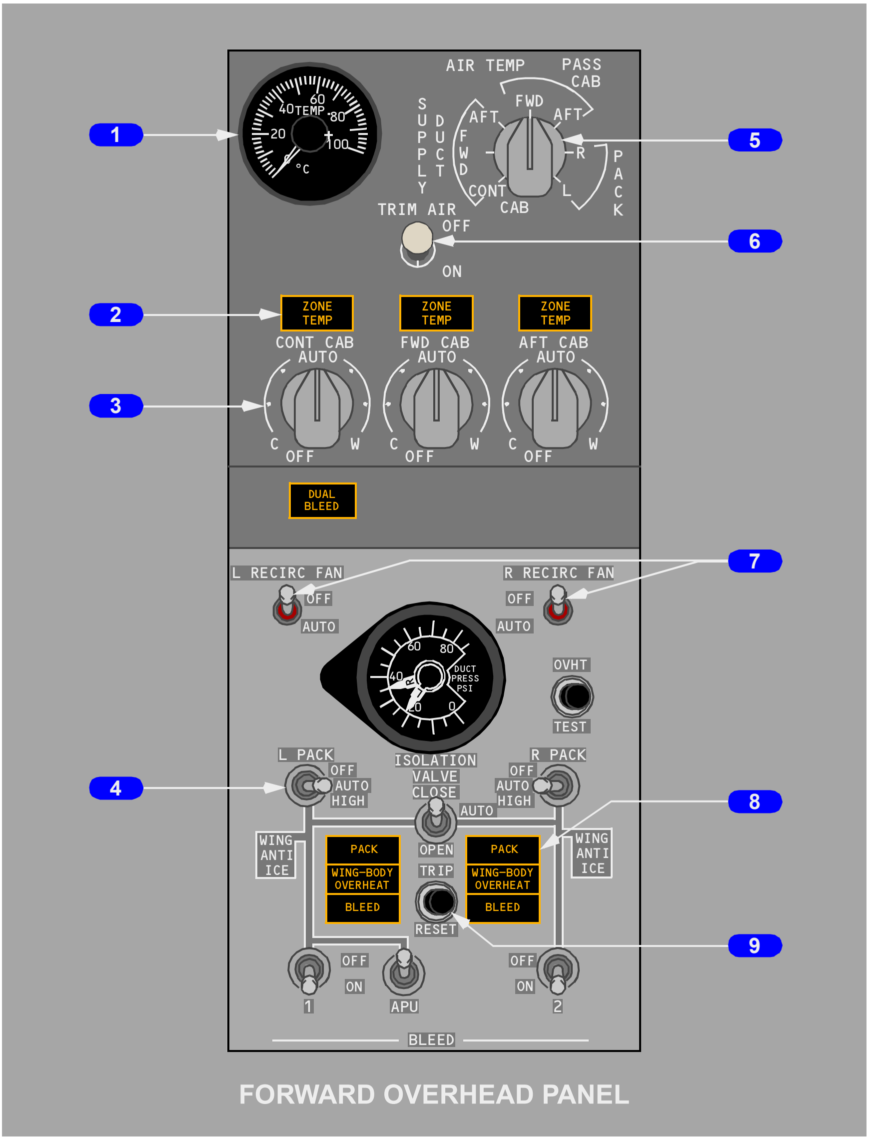
9 TRIP RESET Switch

Push (if fault condition is corrected) –

- resets BLEED, PACK, or ZONE TEMP lights
- related engine bleed air valve opens, or related pack valve opens, or related trim air modulating valve opens.

Lights remain illuminated until reset.

Air Conditioning Controls and Indicators



1 Air Temperature (TEMP) Indicator

Indicates temperature at location selected with AIR TEMP source selector.

2 ZONE TEMP Lights

Illuminated (amber) –

- CONT CAB indicates a duct temperature overheat or failure of the flight deck primary and standby temperature control
- FWD CAB or AFT CAB indicates duct temperature overheat.

3 Temperature Selector

AUTO – provides automatic temperature control for the associated zones. Rotating the control toward C (cool) or W (warm) manually sets the desired temperature.

OFF – closes the associated trim air modulating valve.

4 Air Conditioning PACK Switch

OFF – pack signaled OFF.

AUTO –

- with both packs operating, each pack regulates to low flow
- with one pack operating, operating pack regulates to high flow in flight with flaps up
- when operating one pack from APU (both engine BLEED air switches OFF), regulates to high flow.

HIGH –

- pack regulates to high flow
- provides maximum flow rate on ground with APU BLEED air switch ON.

5 AIR Temperature (TEMP) Source Selector

SUPPLY DUCT – selects appropriate zone supply duct temperature

PASS CAB – selects forward or aft passenger cabin temperature

PACK – selects left or right pack temperatures.

6 TRIM AIR Switch

ON - trim air pressure regulating and shutoff valve signaled open.

OFF - trim air pressure regulating and shutoff valve signaled closed.

7 Recirculation (RECIRC) FAN Switches

OFF - fan signaled off.

AUTO –

- in-flight –
  - the left recirculation fan operates if both packs are operating unless either PACK switch is in HIGH
  - the right recirculation fan operates if both packs are operating unless both PACK switches are in HIGH.
- on the ground –
  - the left recirculation fan operates unless both PACK switches are in HIGH
  - the right recirculation fan operates even if both PACK switches are in HIGH.

8 PACK Light

Illuminated (amber) –

- indicates pack trip off or failure of both primary and standby pack controls, or
- indicates failure of the Flow Control Valve to open when commanded on, or
- an incorrect pack switch configuration after takeoff
  - turning either PACK switch ON will extinguish both PACK lights if lights illuminated because of a configuration problem.

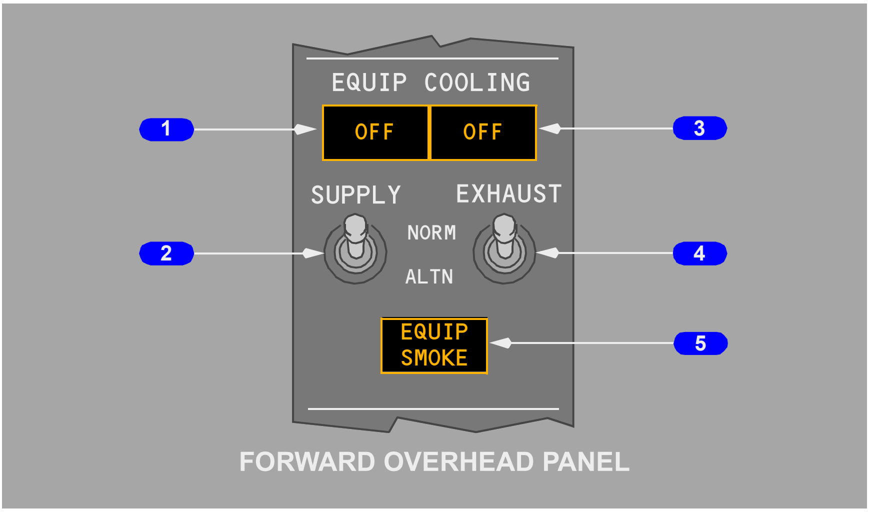
9 TRIP RESET Switch

Push (if fault condition is corrected) –

- resets BLEED, PACK or ZONE TEMP lights
- related engine bleed air valve opens, or related pack valve opens, or related trim air modulating valve opens

Lights remain illuminated until reset.

Equipment Cooling Panel



1 Equipment Cooling Supply OFF Light

Illuminated (amber) – no airflow from selected cooling supply fan.

2 Equipment (EQUIP) COOLING SUPPLY Switch

NORM – normal cooling supply fan activated.

ALTN – alternate cooling supply fan activated.

3 Equipment Cooling Exhaust OFF Light

Illuminated (amber) – no airflow from selected cooling exhaust fan.

4 Equipment (EQUIP) COOLING EXHAUST Switch

NORM – normal cooling exhaust fan activated.

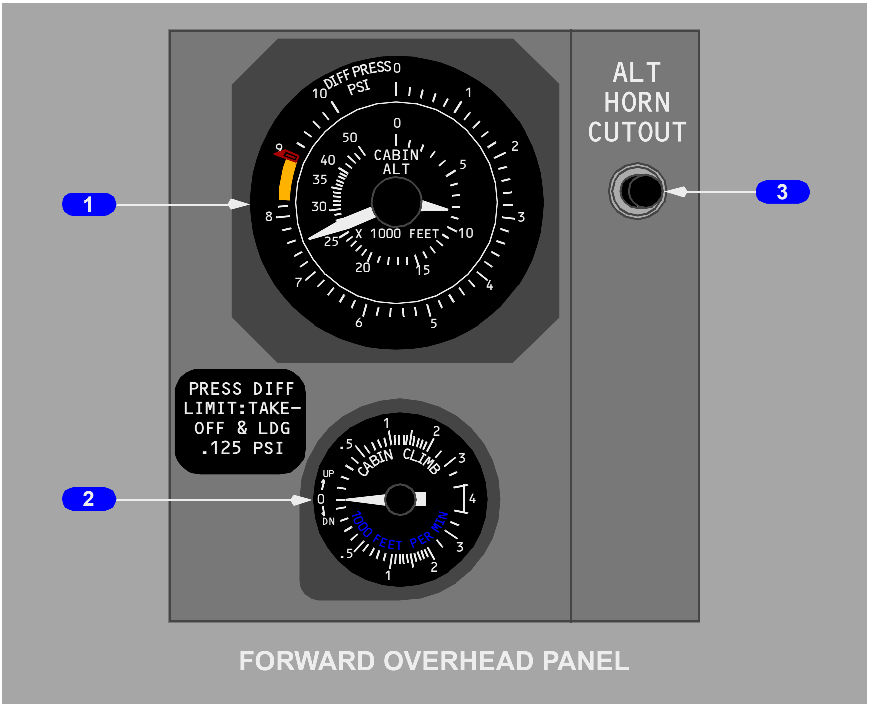
ALTN – alternate cooling exhaust fan activated.

5 Equipment Cooling EQUIP SMOKE Light (amber)

Illuminated – Smoke is detected in the equipment cooling system.

Note: Light extinguishes 30 seconds after smoke is no longer detected.

Cabin Altitude Panel



1 CABIN Altimeter (ALT)/Differential Pressure (DIFF PRESS) Indicator

Inner Scale – indicates cabin altitude in feet.

Note: The CABIN ALT indicator can show a cabin altitude of less than 0 feet and reach the upper end of the cabin altitude scale. This can occur under the following conditions:

- on the ground at airports close to or below sea level.
- in flight when the cabin is pressurized below sea level.

Outer Scale – indicates differential pressure between cabin and ambient in psi.

2 CABIN Rate of CLIMB Indicator

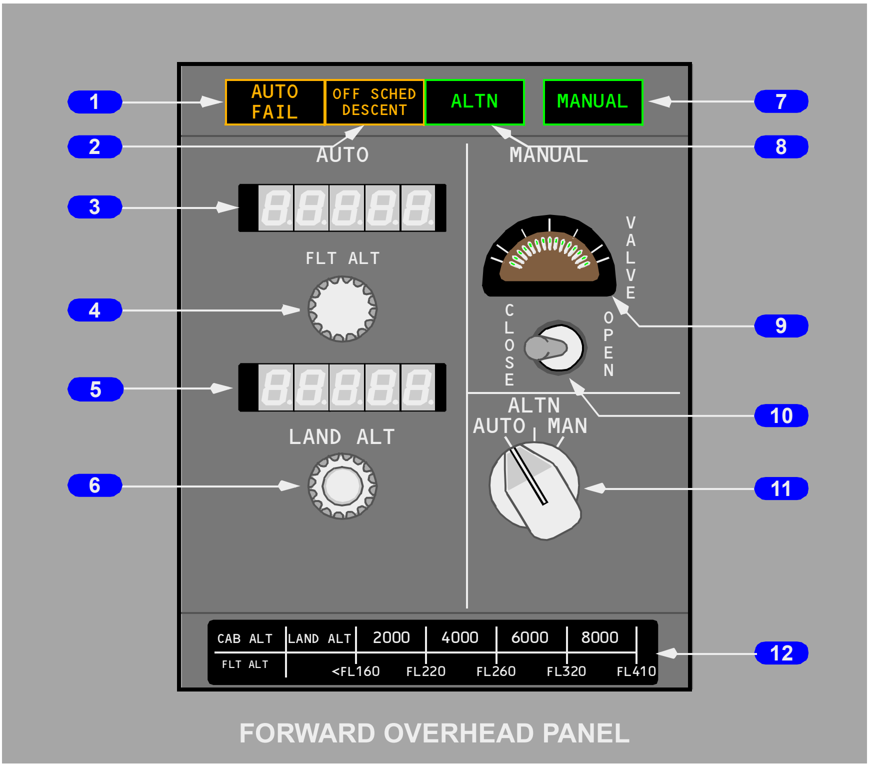
Indicates cabin rate of climb or descent in feet per minute.

3 Altitude (ALT) HORN CUTOUT Switch

Push –

- cuts out intermittent cabin altitude warning horn
- altitude warning horn sounds when cabin exceeds 10,000 feet altitude.

Cabin Pressurization Panel



1 AUTO FAIL Light

Illuminated (amber) – automatic pressurization system failure detected:

- indicates a single controller failure when ALTN light is also illuminated
- indicates a dual controller failure when illuminated alone.

2 OFF Schedule (SCHED) DESCENT Light

Illuminated (amber) – airplane descended before reaching the planned cruise altitude set in the FLT ALT indicator.

3 **Flight Altitude (FLT ALT) Indicator**

- indicates selected cruise altitude
- set before takeoff.

Note: A panel failure detected after a DC power interruption will result in the display of "88888" or all dashes. If cabin altitude and cabin rate are normal, automatic control of cabin pressure is not affected by the failure.

Note: FLT ALT indicator failure may result in the display of non-numbers or a blank display. If the indicator cannot be changed by rotating the flight altitude selector, it may be necessary to monitor the pressurization system to ensure normal operation, especially during climb and descent.

4 **Flight Altitude Selector**

Rotate – set planned cruise altitude. (-1,000 ft. to 42,000 ft. in 500 ft. increments).

5 **Landing Altitude (LAND ALT) Indicator**

- indicates altitude of intended landing field
- set before takeoff.

Note: A panel failure detected after a DC power interruption will result in the display of "88888" or all dashes. If cabin altitude and cabin rate are normal, automatic control of cabin pressure is not affected by the failure.

Note: LAND ALT indicator failure may result in the display of non-numbers or a blank display. If the indicator cannot be changed by rotating the landing altitude selector, it may be necessary to monitor the pressurization system to ensure normal operation, especially during climb and descent.

6 **Landing Altitude Selector**

Rotate – select planned landing field altitude. (-1,000 ft. to 14,000 ft. in 50 ft. increments).

7 **MANUAL Light**

Illuminated (green) – pressurization system operating in the manual mode.

8 **Alternate (ALTN) Light**

Illuminated (green) – pressurization system operating in the alternate automatic mode:

- Illumination of both ALTN and AUTO FAIL lights indicates a single controller failure and automatic transfer to ALTN mode
- pressurization mode selector in ALTN position.

9 Outflow VALVE Position Indicator

- indicates position of outflow valve
- operates in all modes.

10 Outflow Valve Switch (spring–loaded to center)

CLOSE – closes outflow valve electrically with pressurization mode selector in MAN position.

OPEN – opens outflow valve electrically with pressurization mode selector in MAN position.

11 Pressurization Mode Selector

AUTO – pressurization system controlled automatically.

ALTN – pressurization system controlled automatically using ALTN controller.

MAN –

- pressurization system controlled manually by outflow valve switch
- both auto controllers bypassed.

12 Cabin /Flight Altitude (CAB ALT)(FLT ALT) Placard

Used to determine setting for cabin altitude when operating in manual mode.

Intentionally
Blank

Introduction

Air for the bleed air system can be supplied by the engines, APU, or an external air cart/source. The APU or external cart supplies air to the bleed air duct prior to engine start. After engine start, air for the bleed air system is normally supplied by the engines.

The following systems rely on the bleed air system for operation:

- Air conditioning/pressurization
- Wing and engine thermal anti-icing
- Engine starting
- Hydraulic reservoirs pressurization
- Water tank pressurization
- Nitrogen generation system

Switches on the air conditioning panel operate the APU and engine bleed air supply system.

Engine Bleed System Supply

Engine bleed air is obtained from the 4th and 10th stages of the compressor section. When 4th stage low pressure bleed air is insufficient for the bleed air system requirements, the high stage valve modulates open to maintain adequate bleed air pressure. During takeoff, climb, and most cruise conditions, low pressure bleed air from the 4th stage is adequate and the high stage valve remains closed.

Engine Bleed Air Valves

The engine bleed air valve acts as a pressure regulator and shutoff valve. With the engine bleed air switch ON, the valve is DC activated and pressure operated. The valve maintains proper system operating pressure and reduces bleed air outflow in response to high bleed air temperature.

Bleed Sensors

Bleed sensors illuminate the respective BLEED light when engine bleed air temperature or pressure exceeds a predetermined limit. The respective engine bleed air valve closes automatically. The BLEED light also illuminates with a failure within the bleed air system, and both BLEED lights illuminate if an incorrect bleed configuration is present after takeoff or go-around. In case of a bleed system failure, the light might not be resettable. In the case of a configuration discrepancy, the lights illuminate 45 seconds after the flaps are up, and extinguish when either bleed switch is placed ON. Ten minutes after the flaps are up, the airplane can be configured for landing with both engine bleeds OFF and the BLEED lights will not illuminate. The timer resets when the flaps are extended.

Duct Pressure Transmitters

Duct pressure transmitters provide bleed air pressure indications to the respective (L and R) pointers on the bleed air duct pressure indicator. The indicator is AC operated. Differences between L and R duct pressure on the bleed air duct pressure indicator are considered normal as long as there is sufficient air for cabin pressurization.

Isolation Valve

The isolation valve isolates the left and right sides of the bleed air duct during normal operations. The isolation valve is AC operated.

With the isolation valve switch in AUTO, both engine bleed air switches ON, and both air conditioning pack switches AUTO or HIGH, the isolation valve is closed. The isolation valve opens if either engine bleed air switch or air conditioning pack switch is positioned OFF. Isolation valve position is not affected by the APU bleed air switch.

Fan Air Modulating Valve

The Fan Air Modulating Valve (FAMV) is electrically controlled and pneumatically activated. It is spring loaded to the open position.

Precooler

The precooler is used to cool the hot bleed air from the engine. Cooling airflow is extracted from the engine fan-air duct and controlled by the FAMV.

External Air Connection

An external air cart/source provides an alternate air source for engine start or air conditioning.

APU Bleed Air Valve

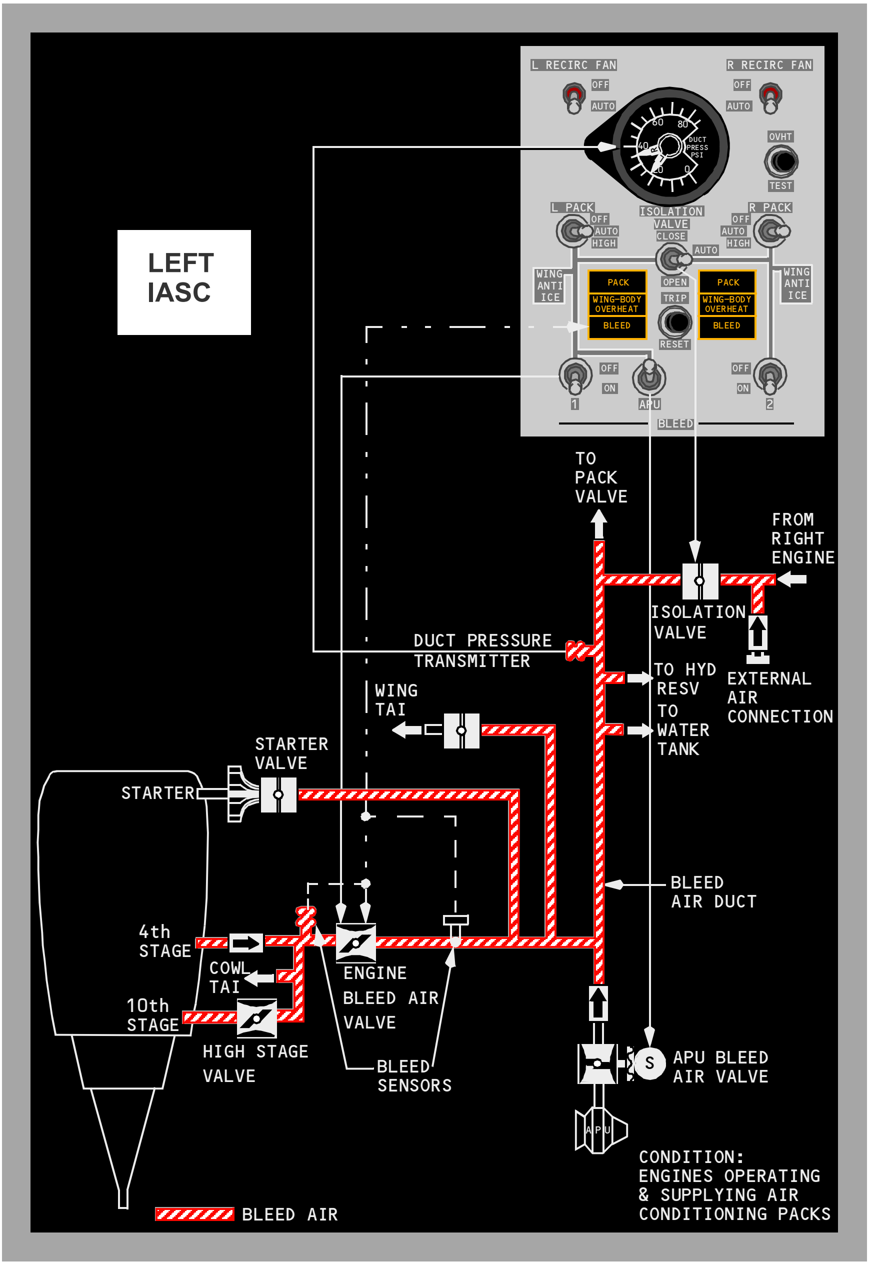
The APU bleed air valve permits APU bleed air to flow to the bleed air duct. The valve closes automatically when the APU is shut down. The APU bleed air valve is DC controlled and pressure operated.

With both the APU and engine bleed air valves open, and the engines operating at idle thrust, there is a possibility of APU bleed air backpressuring the 10th stage modulating and shutoff valve. This would cause the 10th stage valve to close.

DUAL BLEED Light

The DUAL BLEED light illuminates whenever the APU bleed air valve is open and the position of the engine bleed air switches and isolation valve would permit possible backpressure of the APU. Therefore, thrust must be limited to idle with the DUAL BLEED light illuminated.

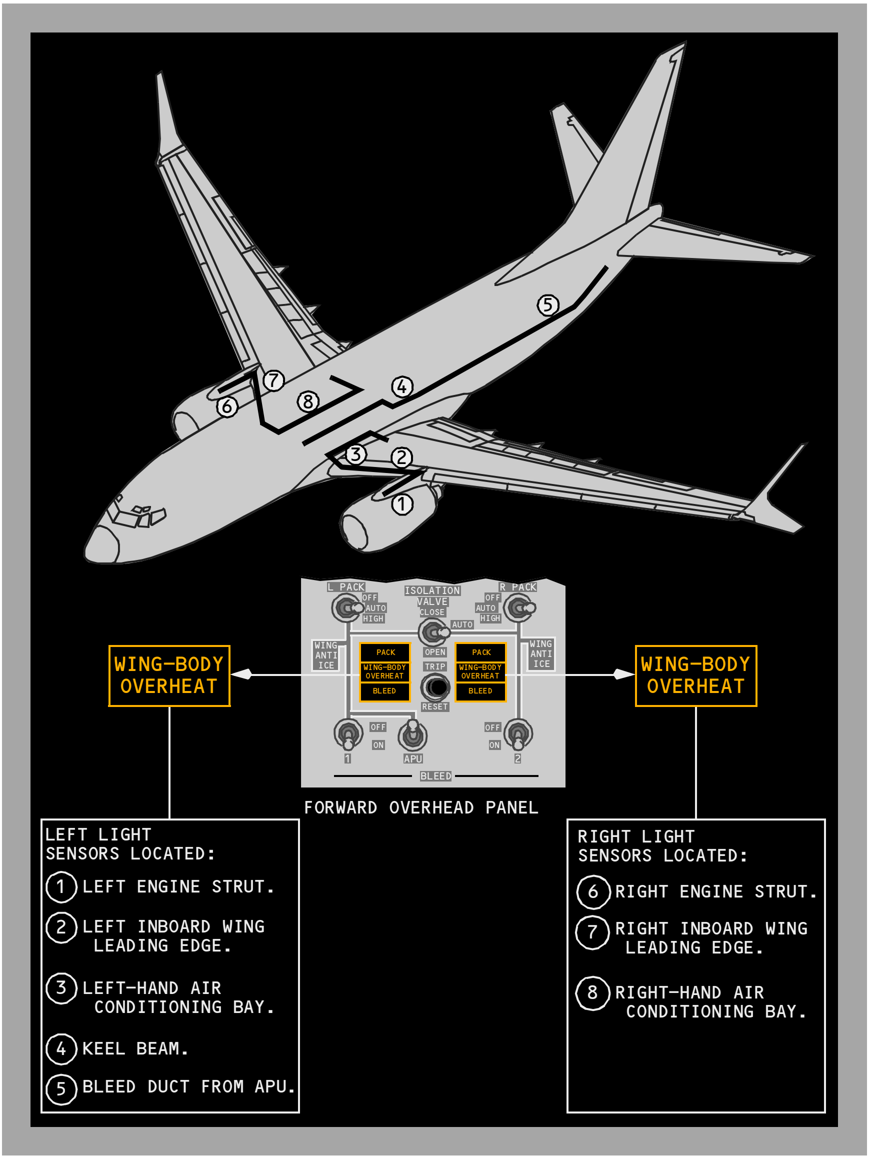
Bleed Air System Schematic



Wing-Body Overheat

A wing-body overheat condition is caused by a bleed air duct leak. It is sensed by the overheat sensors located as shown.

Wing-Body Overheat Ducts and Lights



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Introduction

The air conditioning system provides temperature controlled air by processing bleed air from the engines, APU, or a ground air source in air conditioning packs. Conditioned air from the left pack, upstream of the mix manifold, flows directly to the flight deck. Excess air from the left pack, air from the right pack, and air from the recirculation system is combined in the mix manifold. The mixed air is then distributed through the left and right sidewall risers to the passenger cabin.

Conditioned air for the cabin comes from either the airplane air conditioning system or a preconditioned ground source. Air from the preconditioned ground source enters the air conditioning system through the mix manifold.

Air Conditioning Pack

The flow of bleed air from the main bleed air duct through each air conditioning pack is controlled by the respective pack valve. It is pneumatically actuated and electrically controlled by the Integrated Air Systems Controller (IASC).

Normally, the left pack uses bleed air from engine No. 1, and the right pack uses bleed air from engine No. 2. A single pack in high flow is capable of maintaining pressurization and acceptable temperatures throughout the airplane up to the maximum certified ceiling.

The APU is capable of supplying bleed air for two packs on the ground, or one pack in flight. Most external air carts are capable of supplying adequate bleed air for two pack operation. In flight one engine bleed is capable of supplying bleed air for two packs. On the ground do not operate more than one pack from one engine.

Airflow Control

During normal flight, with both air conditioning pack switches set to AUTO, both engines operating and both engine bleed switches set to ON, the packs provide normal air flow to maintain necessary ventilation. If the air conditioning pack switches are set to HIGH, the packs provide high air flow to increase ventilation.

When the aircraft is not on the ground and the flaps are up, and both air conditioning pack switches are set to AUTO, and the engine bleed switches are both set to ON, if one pack fails or one engine fails or a pack switch is selected to OFF, the remaining pack automatically transfers to high air flow to increase ventilation.

When the aircraft is on the ground or the flaps are down, and both air conditioning pack switches are set to AUTO, and engine bleed switches are both set to ON, if one pack fails or one engine fails or a pack switch is selected to OFF, the remaining pack will not automatically transfer to high air flow. Automatic transferring to high air flow is inhibited in this situation to ensure adequate engine power is available for single engine operations. However, when the APU is operating and the APU bleed switch is set to ON, both engine bleed switches are set to OFF and both pack switches are set to AUTO, automatic transferring to high air flow occurs with a single pack failure, regardless of flap position or air/ground status. Also, in this configuration, the flight crew can force an "APU high flow" rate when either or both pack switches are positioned to HIGH, providing maximum airflow for ventilation when the APU is the only source of ventilation.

Ram Air System

The ram air system provides cooling air for the heat exchangers. Operation of the system is automatically controlled by the packs through operation of ram air inlet doors.

On the ground, or during slow flight with the flaps not fully retracted, the ram air inlet doors move to the full open position for maximum cooling. In normal cruise, the doors modulate between open and closed.

Deflector doors are installed forward of the ram air inlet doors to prevent slush ingestion prior to liftoff and after touchdown. Deflector doors extend when activated electrically by the air–ground safety sensor.

Cooling Cycle

Flow through the cooling cycle starts with bleed air passing through a heat exchanger for cooling. The air then flows to an air cycle machine for refrigeration. The processed cold air is then combined with hot air which has bypassed the air cycle machine, then through a high pressure water separator which removes moisture. This conditioned air then flows into the mix manifold and distribution system.

Overheat protection is provided by temperature sensors located in the cooling cycle. An overheat condition causes the pack valve to close and the PACK light to illuminate.

Pack Temperature Control

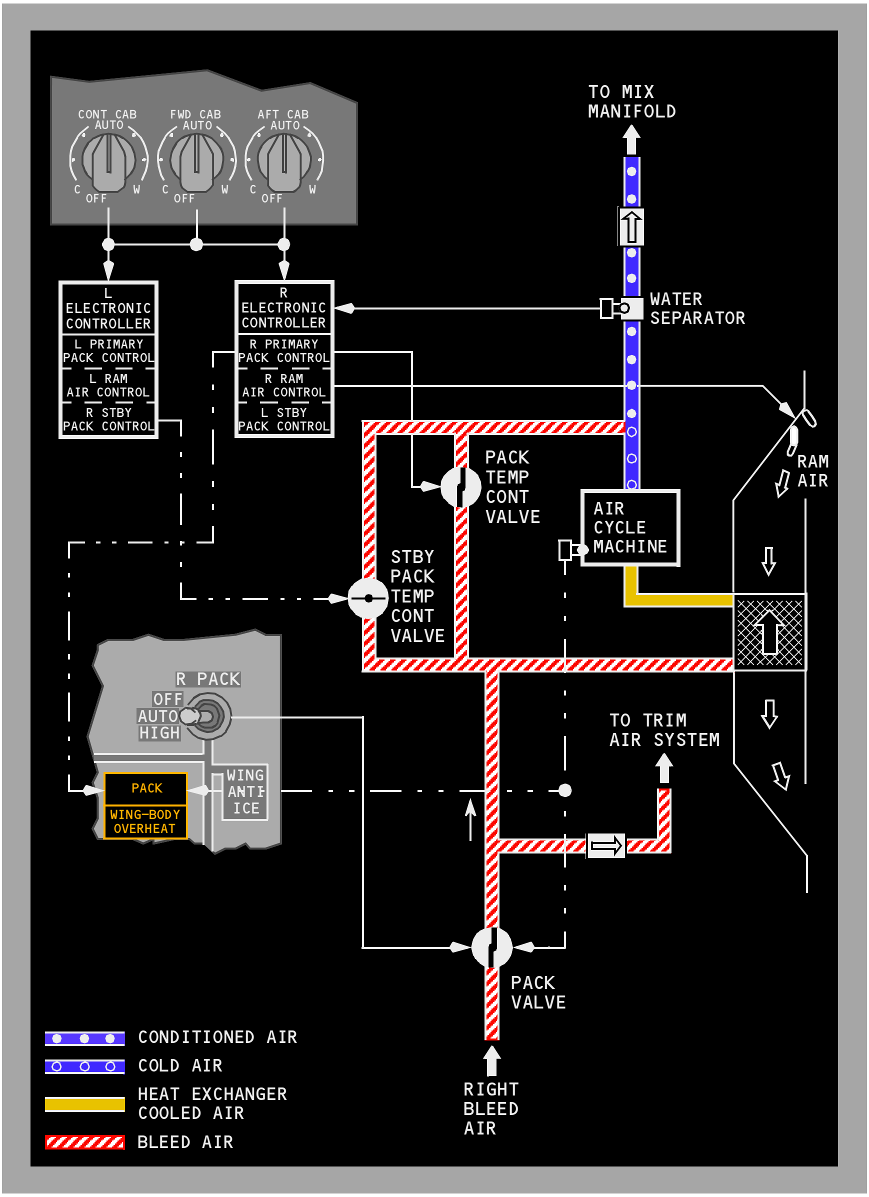
The IASCs command the pack temperature control valve open or closed to satisfy pack discharge requirements.

If a primary pack control fails, the affected pack is controlled by the standby pack control in the opposite controller. A primary or standby pack control failure causes the MAINT, MASTER CAUTION, and OVERHEAD System Annunciator lights to illuminate after landing.

If both the primary and the standby pack controls fail for the same pack, the PACK, MASTER CAUTION, and AIR COND System Annunciator lights illuminate. The pack will continue to operate without control unless excessive temperatures cause the pack to trip off.

Both pack lights illuminate if both pack switches are in the OFF position 45 seconds after the flaps are up following takeoff. Both lights extinguish when either pack switch is placed to AUTO or HIGH.

Air Conditioning Pack Schematic



Zone Temperature Control

There are three zones: flight deck, forward cabin and aft cabin. Desired zone temperature is set by adjusting the individual Temperature Selectors. The selector range is approximately 65°F (18°C) to 85°F (30°C).

The packs produce an air temperature that satisfies the zone which requires the most cooling. Zone temperature is controlled by introducing the proper amount of trim air to the zone supply ducts. The quantity of trim air is regulated by individual trim air modulating valves.

During single pack operation with the TRIM AIR selected ON, zone temperature is controlled the same as during two pack operation. During single pack operation with the TRIM AIR selected OFF, the pack attempts to produce an air temperature to satisfy the average temperature demands of all three zones.

If air in a zone supply duct overheats, the associated amber ZONE TEMP light illuminates, and the associated trim air modulating valve closes. The trim air modulating valve may be reopened after the duct has cooled by pushing the TRIP RESET Switch.

Zone Temperature Control Modes

The right IASC provides primary control for the flight deck (CONT CAB) and the forward passenger cabin zone (FWD CAB). The left IASC provides primary control for the aft passenger cabin zone (AFT CAB) and standby control for the flight deck.

Failure of the right IASC will cause an automatic transfer of control to the left IASC, providing normal temperature control for the flight deck using the CONT CAB temperature selector. The FWD CAB and AFT CAB temperature selectors will operate normally, but the temperature selector settings of the two passenger cabins will be averaged.

Failure of the left IASC will allow the CONT CAB temperature selector to operate normally. The FDW CAB and AFT CAB temperature selectors will also operate normally, but the two temperature settings will be averaged.

Failure of the forward or aft cabin temperature control will cause the associated trim air modulating valve to close. The temperature selectors will operate normally, but the temperature selector settings of the two passenger cabin zones will be averaged. The MAINT, MASTER CAUTION and OVERHEAD System Annunciator lights will illuminate after landing to indicate failure of the associated zone control.

Failure of both the right IASC and the left IASC will illuminate the MASTER CAUTION light, the AIR COND system annunciator light and all three ZONE TEMP lights.

Unbalanced Pack Temperature Control Mode

Any failure affecting the supply of trim air will cause the temperature control system to control both packs independently. If flight deck trim air is lost, the left pack will provide conditioned air to the flight deck at the selected temperature and the right pack will satisfy the demand of the passenger zone which requires the most cooling. If a passenger cabin zone trim air, or all trim air is lost, the forward and aft zone temperature demands will be averaged for control of the right pack.

If any individual zone is transferred OFF, the Temperature Selector setting will be ignored by the temperature control system.

Standby Pack Average Temperature

If all zone controls and primary pack controls fail, the standby pack controls command the packs to produce air temperatures which will satisfy the average temperature demand of the two cabin zones. The trim air modulating valves will close. The flight deck zone Temperature Selector will have no effect on the standby pack controls.

Fixed Cabin Temperature

If all Temperature Selectors are positioned OFF, the IASCs will cause the left pack to maintain a fixed temperature of 75°F (24°C) and the right pack to maintain 65°F (18°C) as measured at the pack temperature sensor.

Air Conditioning Distribution

Conditioned air is collected in the mix manifold. The temperature of the air is directly related to the setting of the Temperature Selectors.

Overheat detection is provided by temperature sensors located downstream of the packs and the mix manifold. An overheat condition causes the appropriate trim air modulating valve to close and the ZONE TEMP light to illuminate.

Flight Deck

Since the flight deck requires only a fraction of the air supply provided by the left pack, most of the left pack output is routed to the mix manifold.

Conditioned air for the flight deck branches into several risers which end at the floor, ceiling and foot level outlets. Air diffusers on the floor under each seat deliver continuous air flow as long as the manifold is pressurized.

Overhead diffusers are located on the flight deck ceiling, above and aft of the No. 3 windows. Each of these outlets can be opened or closed as desired by turning a slotted adjusting screw.

There is also a dual purpose valve behind the rudder pedal of each pilot. These valves provide air for warming the pilots' feet and for defogging the inside of the No. 1 windows. Each valve is controlled by knobs located on the Captain's and First Officer's panels.

Passenger Cabin

The passenger cabin air supply distribution system consists of the mix manifold, sidewall risers, and an overhead distribution duct.

Sidewall risers go up the right and left walls of the passenger cabin to supply air to the overhead distribution duct. The overhead distribution duct routes conditioned air to the passenger cabin. It extends from the forward to the aft end of the ceiling along the airplane centerline and also supplies the sidewall diffusers.

Recirculation Fans

The recirculation fan system reduces the air conditioning system pack load and the engine bleed air demand. Air from the passenger cabin and electrical equipment bay is drawn to the forward cargo bay where it is filtered and recirculated to the mix manifold. The fans are driven by AC motors. Each recirculation fan operates only if the respective RECIRC FAN Switch is selected to AUTO. In flight, the left recirculation fan operates if both packs are operating unless either PACK switch is in HIGH. The right recirculation fan operates in flight if both packs are operating unless both PACK switches are in HIGH. On the ground, the left recirculation fan operates unless both PACK switches are in HIGH and the right recirculation fan operates even if both PACK switches are in HIGH.

Equipment Cooling

The equipment cooling system cools electronic equipment in the flight deck and the E & E bay.

The equipment cooling system consists of a supply duct and an exhaust duct. Each duct has a normal fan and an alternate fan. The supply duct supplies cool air to the flight deck displays and electronic equipment in the E & E bay. The exhaust duct collects and discards warm air from the flight deck displays, the overhead and aft electronic panels, circuit breaker panels in the flight deck, and electronic equipment in the E & E bay. Two smoke detectors are installed downstream of the fans. The EQUIP SMOKE, MASTER CAUTION, and OVERHEAD System Annunciator lights will illuminate if smoke is detected. When smoke is detected the system will automatically set the packs to high flow, turn the E/E Cooling Supply Fan(s) OFF for approximately 5 minutes, overboard exhaust valve opens to the smoke position and the recirculation fans turn off. The E/E Cooling Supply Fans return to normal operations 5 minutes after the first detection of smoke. If smoke is re-detected, the Supply Fans turn OFF for another 5 minutes. The OFF light for the supply fan does not illuminate during this automatic shut off.

Loss of airflow due to failure of an equipment cooling fan results in illumination of the related equipment cooling OFF light. Selecting the alternate fan should restore airflow and extinguish the OFF light within approximately 5 seconds.

In the event of a forward cargo fire warning, the equipment cooling exhaust fan is shut off and the equipment cooling exhaust OFF light is inhibited.

If an overtemperature occurs on the ground, alerting is provided through the crew call horn in the nose wheel well.

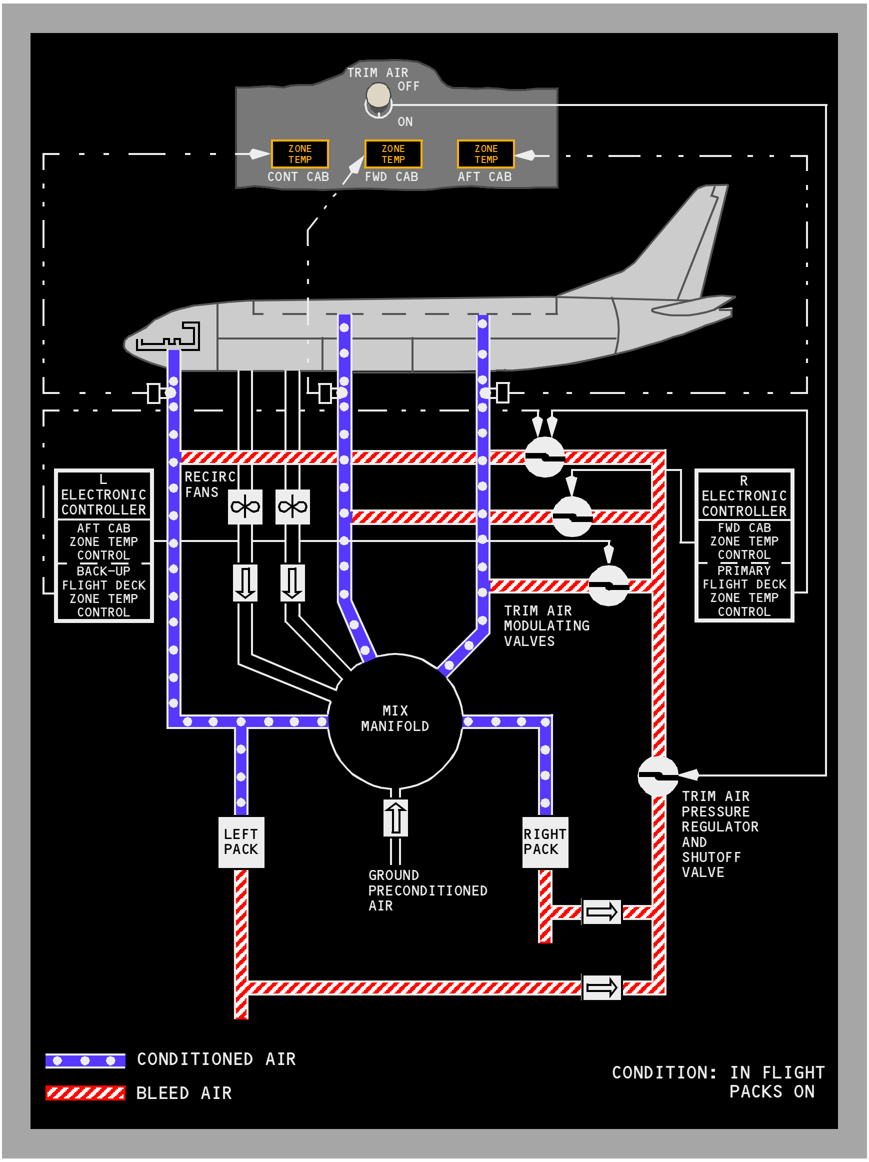
Forward Cargo Compartment

The recirculation fan system circulates air from the passenger cabin around the lining of the forward cargo compartment. When the overboard exhaust valve is closed, exhaust air from the equipment cooling system is also diffused to the lining of the forward cargo compartment for additional inflight heating.

Conditioned Air Source Connection

A ground air conditioning source may be connected to the mix manifold to distribute preconditioned air throughout the airplane.

Air Conditioning Distribution Schematic



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Introduction

Cabin pressurization is controlled during all phases of airplane operation by the cabin pressure control system. The cabin pressure control system includes two identical automatic controllers available by selecting AUTO or ALTN and a manual (MAN) pilot–controlled mode.

The system uses bleed air supplied to and distributed by the air conditioning system. Pressurization and ventilation are controlled by modulating the outflow valve and the overboard exhaust valve.

Pressure Relief Valves

Two pressure relief valves provide safety pressure relief by limiting the differential pressure to a maximum of 9.1 psi. A negative relief valve prevents external atmospheric pressure from exceeding internal cabin pressure.

Cabin Pressure Controller

Cabin altitude is normally rate–controlled by the cabin pressure controller up to a cabin altitude of 8,000 feet at the airplane maximum certified ceiling of 41,000 feet.

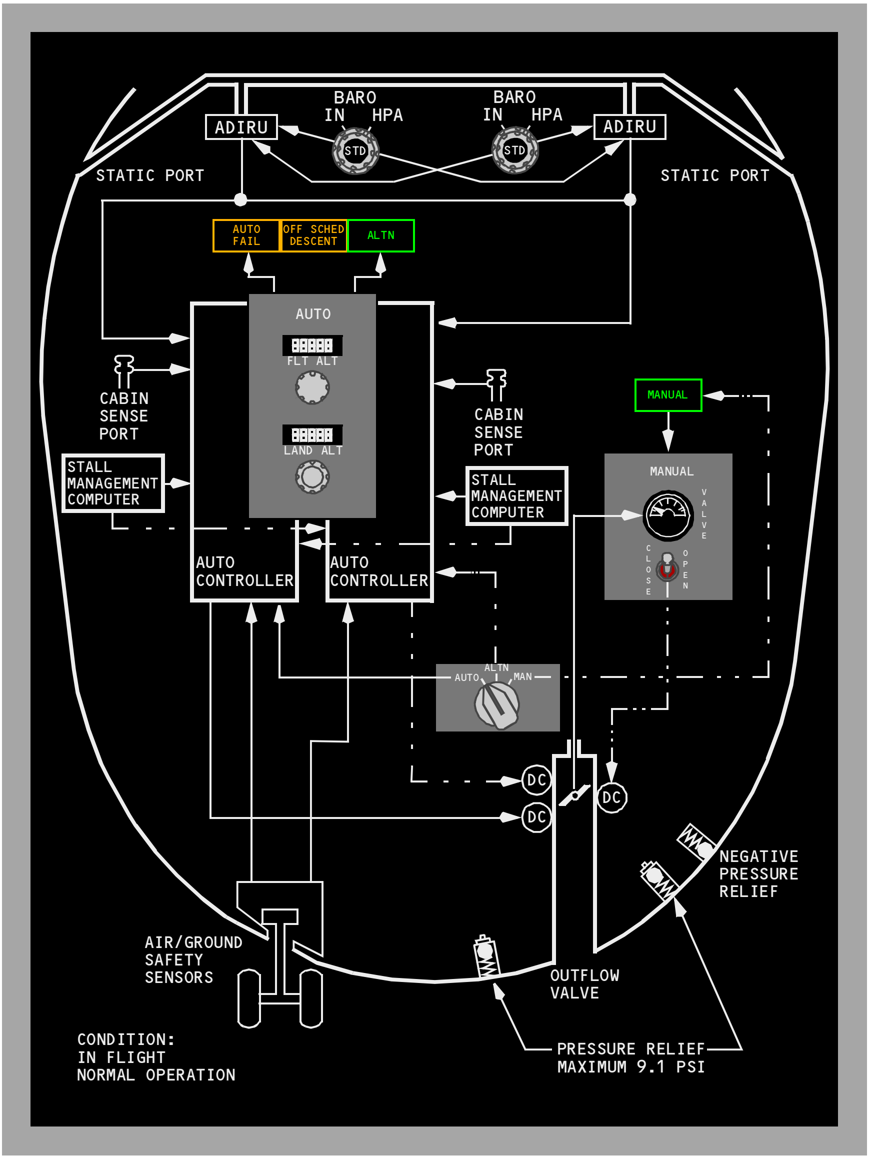
The cabin pressure controller controls cabin pressure in the following modes:

- AUTO – Automatic pressurization control; the normal mode of operation. Uses DC motor.
- ALTN – Automatic pressurization control; the alternate mode of operation. Uses DC motor.
- MAN – Manual control of the system using DC motor.

The air data inertial reference units (ADIRUs) provide ambient static pressure, baro corrected altitude, non-corrected altitude and calibrated airspeed to both automatic controllers. The ADIRUs receive barometric corrections from the Captain’s and First Officer’s BARO reference selectors.

The automatic controllers also receive throttle position from both stall management computers and signals from the air/ground sensors.

Cabin Pressure Control System Schematic



Pressurization Outflow

Cabin air outflow is controlled by the outflow valve and the overboard exhaust valve. A small amount is also exhausted through toilet and galley vents, miscellaneous fixed vents, and by seal leakage.

Outflow Valve

The outflow valve is the overboard exhaust exit for the majority of the air circulated through the passenger cabin. Passenger cabin air is drawn through foot level grills, down around the aft cargo compartment, where it provides heating, and is discharged overboard through the outflow valve.

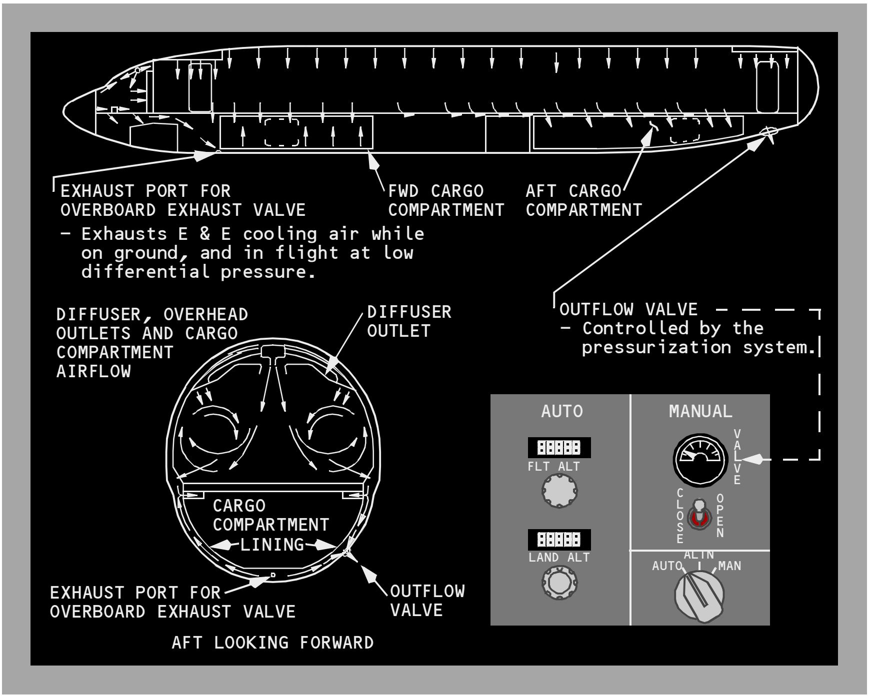
Overboard Exhaust Valve

On the ground and in flight with low differential pressure, the overboard exhaust valve is open and warm air from the E & E bay is discharged overboard. In flight, at higher cabin differential pressures, the overboard exhaust valve is normally closed and exhaust air is diffused to the lining of the forward cargo compartment.

However, the overboard exhaust valve is driven open if either pack switch is in high and the right recirculation fan is off. This allows for increased ventilation in the smoke removal configuration.

Note: During pressurized flight, the overboard exhaust valve will be commanded to a smoke mode upon a Forward Cargo Fire Alarm.

Pressurization Outflow Schematic



Auto Mode Operation

The AUTO system consists of two identical controllers, with one controller alternately sequenced as the primary operational controller for each new flight. The other automatic controller is immediately available as a backup.

In the AUTO or ALTN mode, the pressurization control panel is used to preset two altitudes into the auto controllers:

- FLT ALT (flight or cruise altitude).
- LAND ALT (landing or destination airport altitude).

Takeoff airport altitude (actually cabin altitude) is fed into the auto controllers at all times when on the ground.

The air/ground safety sensor signals whether the airplane is on the ground or in the air. On the ground and at lower power settings, the cabin is depressurized by driving the outflow valve to the full open position.

The cabin begins to pressurize on the ground at higher power settings. The controller modulates the outflow valve toward close, slightly pressurizing the cabin. This ground pressurization of the cabin makes the transition to pressurized flight more gradual for the passengers and crew, and also gives the system better response to ground effect pressure changes during takeoff.

In the air, the auto controller maintains a proportional pressure differential between airplane and cabin altitude. By increasing the altitude at a rate proportional to the airplane climb rate, cabin altitude change is held to the minimum rate required.

An amber OFF SCHED DESCENT light illuminates if the airplane begins to descend without having reached the preset cruise altitude; for example, a flight aborted in climb and returning to the takeoff airport. The controller programs the cabin to land at the takeoff field elevation without further pilot inputs. If the FLT ALT indicator is changed, the automatic abort capability to the original takeoff field elevation is lost.

The cruise mode is activated when the airplane climbs to within 0.25 psi of the selected FLT ALT. During cruise the controller maintains the lowest possible cabin altitude based on the differential pressure limits indicated in the table below. In certain circumstances the selected LAND ALT may exceed the target cabin altitude determined by the differential pressure limits. In these cases, the controller will maintain a cabin altitude slightly below the selected LAND ALT. Deviations from flight altitude can cause the pressure differential to vary as the controller modulates the outflow valve to maintain a constant cabin altitude.

Selected FLT ALT	Differential Pressure Limit
At or below 28,000 feet	7.45 psid
28,000 feet to 37,000 feet	7.80 psid
Above 37,000 feet	8.35 psid

The descent mode is activated when the airplane descends 0.25 psi below the selected FLT ALT. The cabin begins a proportional descent to slightly below the selected LAND ALT. The controller programs the cabin to land slightly pressurized so that rapid changes in altitude during approach result in minimum cabin pressure changes.

While taxiing in, the controller drives the outflow valve slowly to the full open position depressurizing the cabin.

An amber AUTO FAIL light illuminates if any of the following conditions occurs:

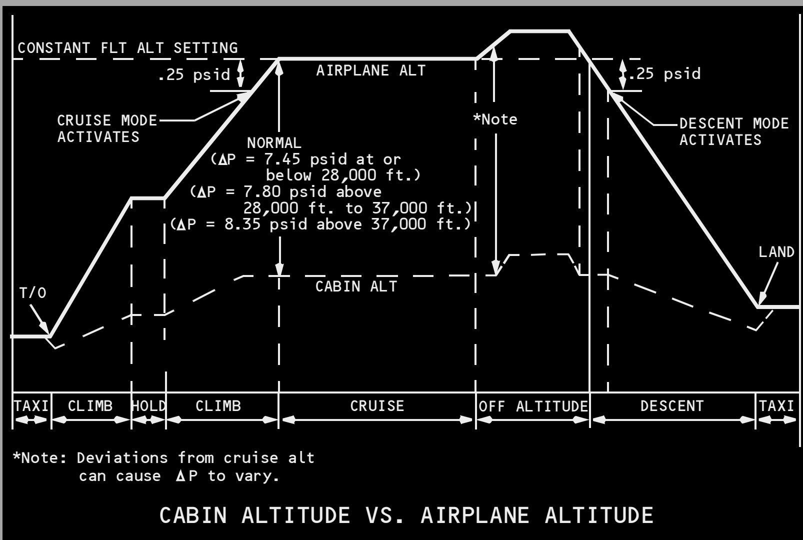
- Loss of DC power
- Controller fault
- Outflow valve control fault
- Excessive differential pressure (> 8.75 psi)*
- Excessive rate of cabin pressure change (±2000 sea level feet/minute)*
- High cabin altitude (above 15,800 feet).*

*If controller is not responding properly

With illumination of the AUTO FAIL light, the pressure control automatically transfers to the other auto controller (ALTN mode).

Moving the pressurization mode selector to the ALTN position extinguishes the AUTO FAIL light, however the ALTN light remains illuminated to indicate single channel operation.

Flight Path Events – Auto Mode



Manual Mode Operation

A green MANUAL Light illuminates with the pressurization mode selector in the MAN position.

Manual control of the cabin altitude is used if both the AUTO and ALTN modes are inoperative. In the MAN mode, the outflow valve position switch is used to modulate the outflow valve by monitoring the cabin altitude panel and valve position on the outflow valve position indicator. A separate DC motor, powered by the DC standby system, drives the outflow valve at a slower rate than the automatic modes. Outflow valve full range of motion takes up to 20 seconds.

Anti-Ice, Rain — Chapter 3
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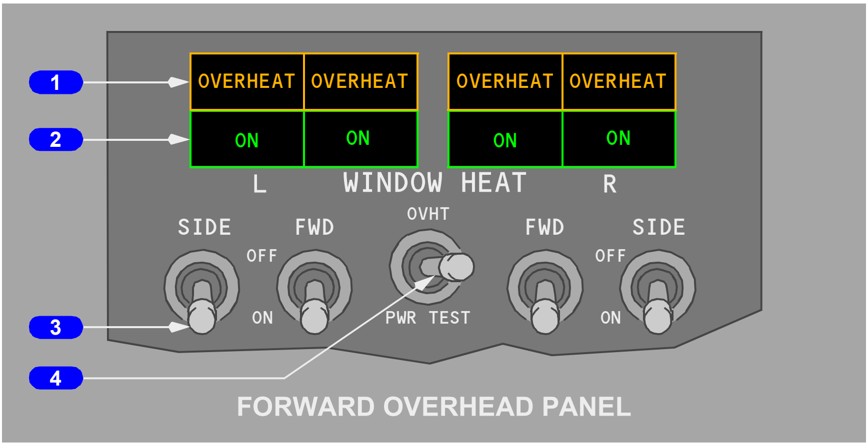
Window Heat Panel



1 Window OVERHEAT Lights

Illuminated (amber) – overheat condition is detected.

Note: OVERHEAT lights also illuminate if electrical power to window(s) is interrupted.

2 Window Heat ON Lights

Illuminated (green) – window heat is being applied to selected window(s).

Extinguished –

- switch is OFF, or
- an overheat is detected, or
- a system failure has occurred
- system is at correct temperature.

3 WINDOW HEAT Switches

ON – window heat is applied to selected window(s).

OFF – window heat not in use.

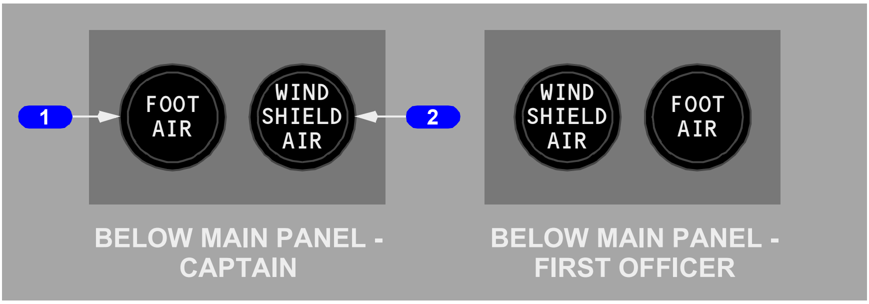
4 WINDOW HEAT Test Switch (spring–loaded to neutral)

OVHT – simulates an overheat condition.

PWR TEST – provides a confidence test.

Note: Refer to Supplementary Normal Procedures for Window Heat Test procedures.

Windshield/Foot Air Controls



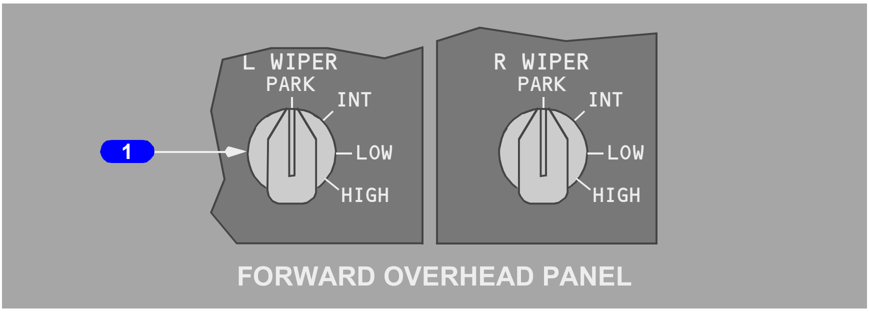
1 FOOT AIR Controls

PULL – supplies conditioned air to pilots' leg positions.

2 WINDSHIELD AIR Controls

PULL – supplies conditioned air to number 1 windows for defogging.

Windshield Wiper Selector Panel



1 Windshield WIPER Selectors

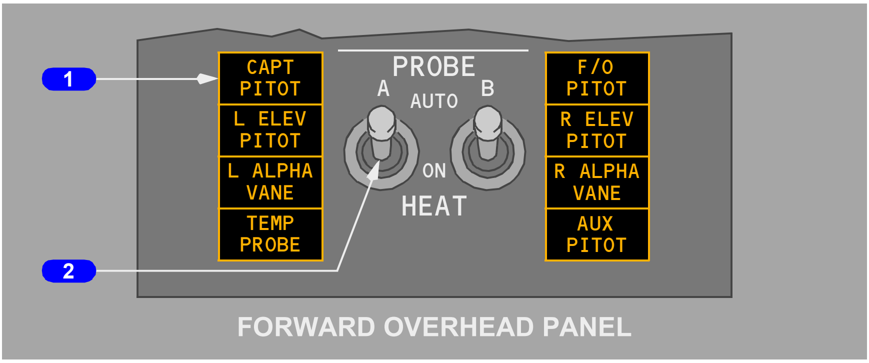
PARK – turns off wiper motors and stows wiper blades.

INT – seven second intermittent operation.

LOW – low speed operation.

HIGH – high speed operation.

Probe Heat Panel



1 Probe Heat Lights

Illuminated (amber) – related probe not heated.

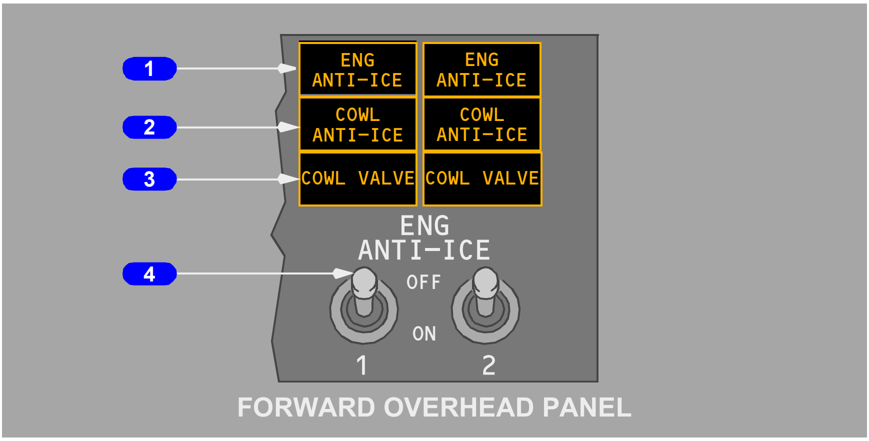
Note: If operating on standby power, probe heat lights do not indicate system status.

2 PROBE HEAT Switches

ON – power is supplied to heat related system.

AUTO – power is automatically supplied to both A and B probe heat systems when either engine is running.

Engine Anti–Ice Panel



1 ENG ANTI–ICE Lights

Illuminated (amber) – indicates cowl thermal anti-ice system has been inhibited due to a system failure or when an engine core anti-ice valve fails closed.

2 COWL ANTI–ICE Lights

Illuminated (amber) – indicates an overpressure condition in duct downstream of engine cowl anti–ice valve.

3 COWL VALVE Lights

Illuminated (amber) –

- momentary – related cowl anti–ice valve is in transit
- steady – cowl anti–ice valve position disagrees with related ENGINE ANTI–ICE switch position.

Extinguished – related cowl anti–ice valve is closed (switch OFF), or related cowl anti–ice valve is open (switch ON).

4 ENGINE ANTI–ICE Switches

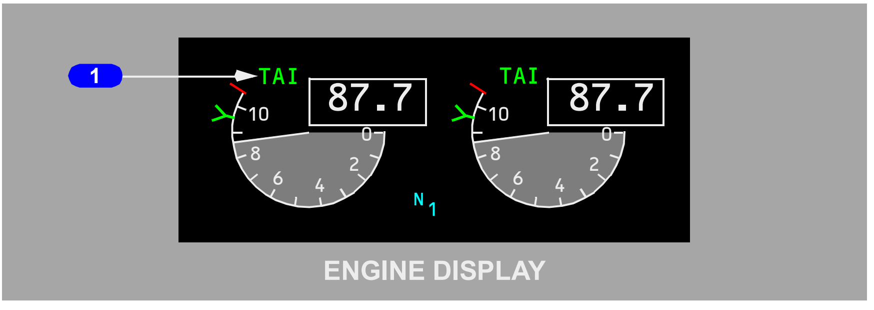
ON –

- related cowl anti–ice valve is open
- stick shaker logic is set for icing conditions.
- Green TAI indication shows on the engine display.

OFF –

- related cowl anti–ice valve is closed
- stick shaker logic returns to normal if wing anti–ice has not been used in flight
- Green TAI indication on the engine display extinguishes.

Thermal Anti–Ice Indication

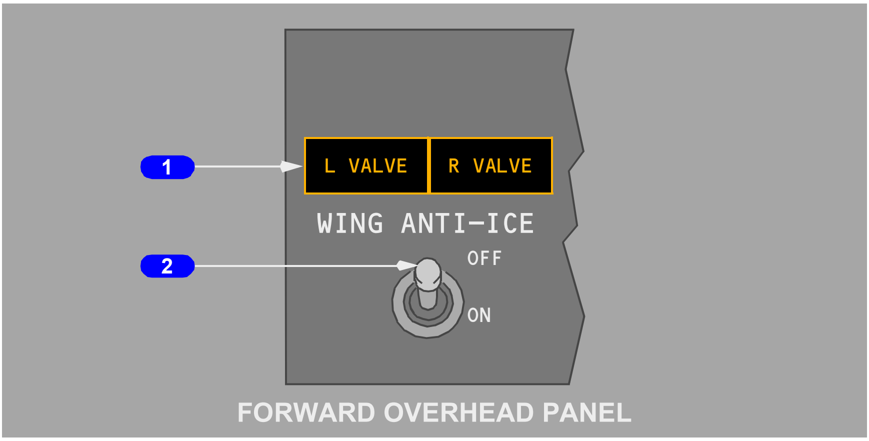


1 Thermal Anti–Ice Indications

Illuminated –

- Green – cowl anti–ice valve(s) open
- Amber – cowl anti–ice valve is not in position indicated by related engine anti–ice switch.

Wing Anti–Ice Panel



1 Wing VALVE Lights

Illuminated (amber) –

- momentary – related wing anti–ice valve is in transit
- steady – wing anti–ice valve position disagrees with related WING ANTI–ICE switch position.

Extinguished – related wing anti–ice valve is closed (switch OFF), or related wing anti–ice valve is open (switch ON).

2 WING ANTI–ICE Switch

OFF – wing anti–ice control valves are closed.

ON (in the air) –

- wing anti–ice control valves are open
- stick shaker logic is set for icing conditions.

Note: Stick shaker logic remains set for icing conditions for the remainder of the flight, regardless of subsequent WING ANTI–ICE switch position.

ON (on the ground) –

- wing anti–ice control valves open if thrust on both engines is below takeoff warning setting and temperature inside both distribution ducts is below thermal switch activation temperature
- control valves close if either engine thrust is above takeoff warning setting or thermal switch is activated in either distribution duct. Switch remains ON
- switch trips OFF at lift–off.

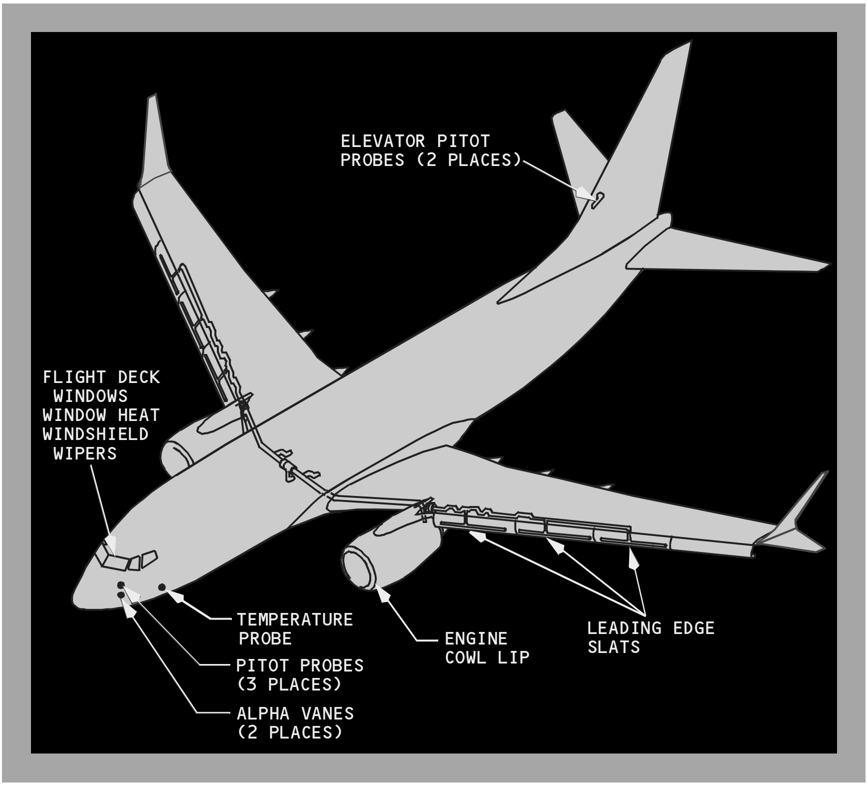
Introduction

Thermal anti-icing (TAI), electrical anti-icing, and windshield wipers are the systems provided for ice and rain protection.

The anti-ice and rain systems include:

- Flight Deck Window Heat
- Windshield Wipers
- Probe and Sensor Heat
- Engine Anti-Ice System
- Wing Anti-Ice System

Anti-Ice Components Diagram



Flight Deck Window Heat

Flight deck window numbers 1 and 2 consist of glass panes laminated to each side of a vinyl core. Flight deck window number 3 consists of two acrylic panes separated by an air space.

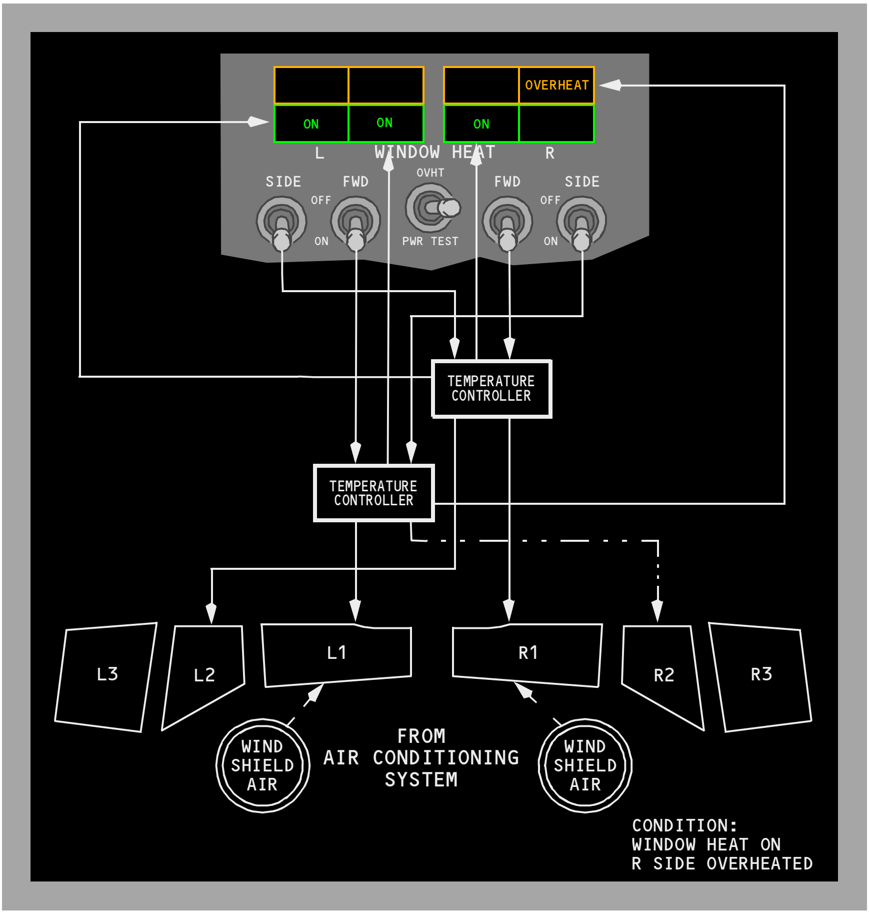
A conductive coating on the outer glass pane of window numbers 1 and 2 permits electrical heating to prevent ice build–up and fogging. Window number 3 is not electrically heated.

Flight Deck Window Heat Operation

The FWD WINDOW HEAT switches control heat to window No. 1. The SIDE WINDOW HEAT switches control heat to window numbers 2.

Temperature controllers maintain window numbers 1 and 2 at the correct temperature to ensure maximum strength of the windows in the event of bird impact. Power to window numbers 1 and 2 is automatically removed if an overheat condition is detected.

Flight Deck Window Heat Schematic



Windshield Wipers

The rain removal system for the forward windows consists of windshield wipers and a permanent rain repellent coating on the windows.

CAUTION: Windshield scratching will occur if the windshield wipers are operated on a dry windshield.

Probe and Sensor Heat

Pitot probes, the total air temperature probe and the alpha vanes are electrically heated. Static ports are not heated. When operating on standby power, only the captain's pitot probe is heated, however, the CAPT PITOT light does not illuminate for a failure.

Note: The pitot probe for standby airspeed is not heated when the airplane is on standby power.

Engine Anti–Ice System

Engine bleed air thermal anti–icing prevents the formation of ice on the engine cowl lip and engine core.

Cowl anti–ice operation is controlled by individual ENG ANTI–ICE switches. The cowl anti–ice system may be operated on the ground and in flight.

Core anti-ice operation is automatically controlled by the Electronic Engine Control (EEC) with no crew input or indication of normal operation. The EEC controls the core anti-ice system by directing bleed air to the engine core as needed based on engine parameters and atmospheric conditions.

Engine Anti–Ice System Operation

Each cowl anti–ice valve is electrically controlled and pressure actuated. Positioning the ENG ANTI–ICE switches to ON:

- allows engine bleed air to flow through the cowl anti–ice valve for cowl lip anti–icing
- sets stall warning logic for icing conditions.
- sets engine idle speed per the following table:

Flap Setting	Engine Idle Speed
UP	Icing Idle
Less than 15 Degrees	Approach Idle
15 Degrees or Greater	Approach Idle

Note: Stall warning logic adjusts stick shaker and minimum maneuver speed bars on the airspeed indicator. FMC displayed VREF is not adjusted automatically.

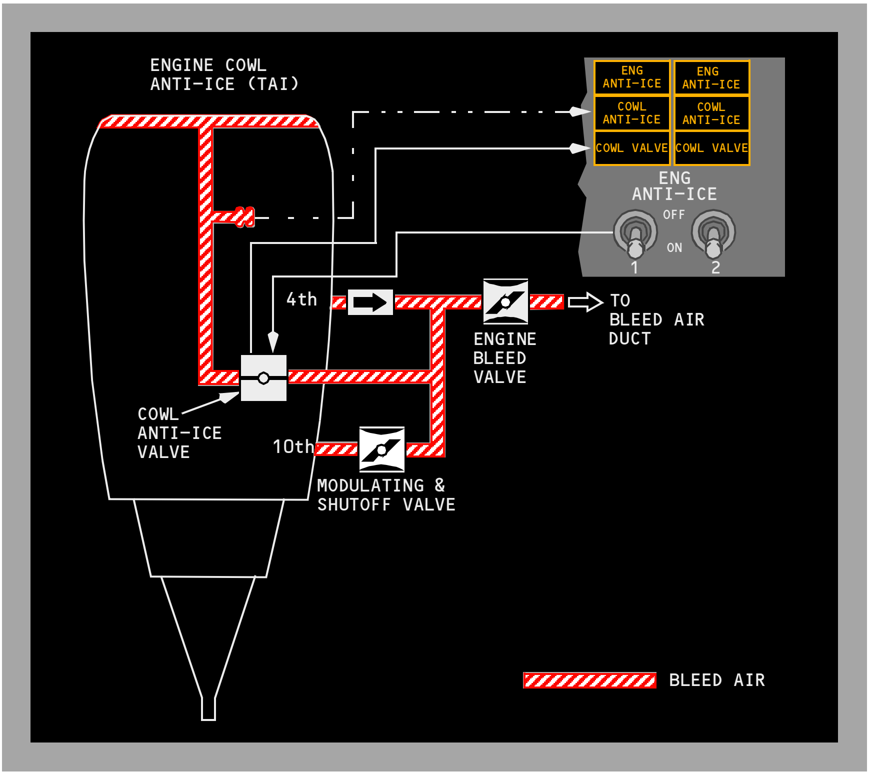
Note: Stall warning logic, airspeed indications, and minimum maneuver speeds on the airspeed indicator return to normal when engine anti–ice is positioned OFF if wing anti–ice has not been used in flight.

Note: When ENG ANTI-ICE switches are OFF, the EEC selects flight idle when flaps are less than 15 degrees; approach idle when flaps are 15 degrees or greater.

If the cowl anti–ice valve fails to move to the position selected by the ENG ANTI–ICE switch, the COWL VALVE light illuminates and remains illuminated, and an amber TAI indication illuminates on the engine display after a short delay.

The amber COWL ANTI–ICE light illuminates due to excessive pressure in the duct leading from the cowl anti–ice valve to the cowl lip.

Engine Anti–Ice System Schematic



Wing Anti–Ice System

The wing anti–ice system provides protection for the three inboard leading edge slats by using bleed air. The wing anti–ice system does not include the leading edge flaps or the outboard leading edge slats.

The wing anti–ice control valves are AC motor–operated. With a valve open, bleed air flows to the three leading edge inboard slats, and is then exhausted overboard. The wing anti–ice system is effective with the slats in any position.

Wing Anti–Ice System Operation

On the ground, positioning the WING ANTI–ICE switch ON opens both control valves if thrust on both engines is below the setting for takeoff warning activation and the temperature inside both wing distribution ducts is less than the thermal switch activation temperature.

Both valves close if either engine thrust is above the takeoff warning setting or either temperature sensor senses a duct overtemperature. The valves automatically reopen if thrust on both engines is reduced and both temperature sensors are cool.

If either engine is above the takeoff warning setting and the WING ANTI–ICE switch is ON, the L VALVE and R VALVE lights are inhibited. The switch remains in the ON position regardless of control valve position. The WING ANTI–ICE switch automatically trips OFF at lift–off when the air/ground sensor goes to the air mode.

Positioning the WING ANTI–ICE switch to ON in flight:

- opens both control valves
- sets stall warning logic for icing conditions.

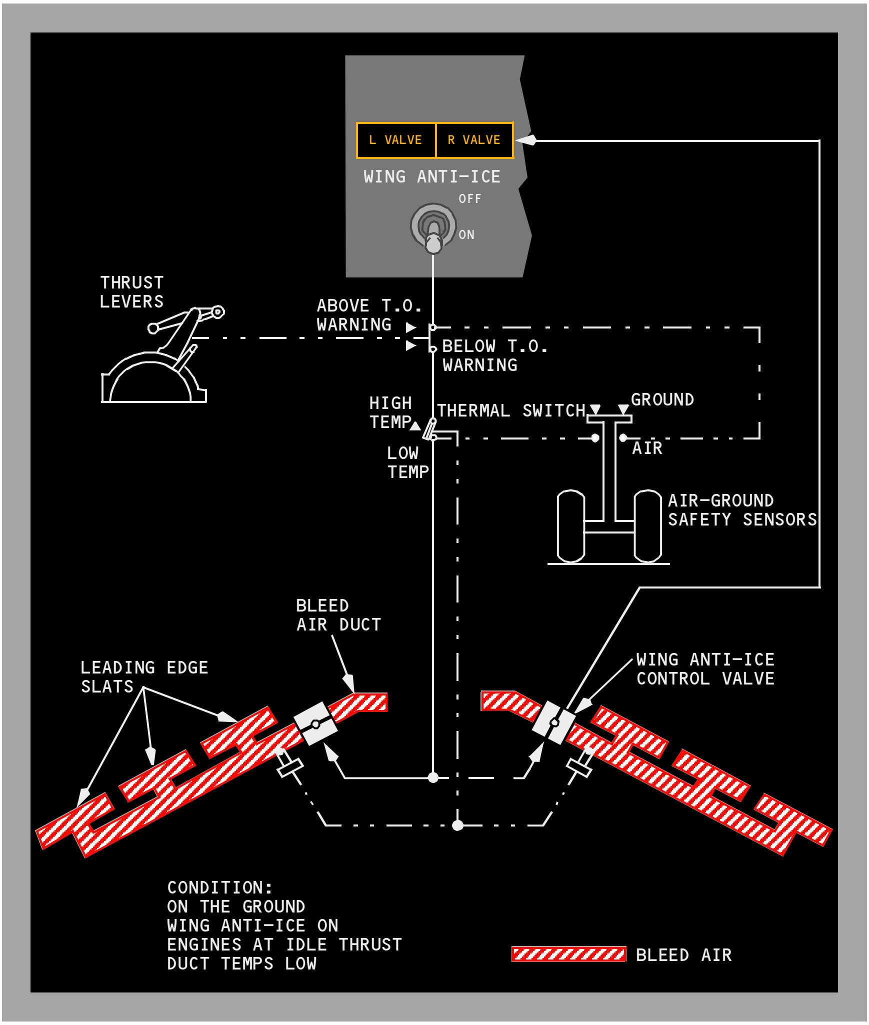
Note: Stall warning logic adjusts stick shaker and minimum maneuver speed bars on airspeed indications. FMC displayed VREF is not adjusted automatically.

Note: Stall warning logic remains set for icing conditions for the remainder of the flight, regardless of subsequent WING ANTI–ICE switch position.

Duct temperature and thrust setting logic are disabled and have no affect on control valve operation in flight.

Illumination of the amber L VALVE and/or R VALVE light(s) indicates the related wing anti-ice control valve position disagrees with the WING ANTI-ICE switch position.

Wing Anti–Ice System Schematic



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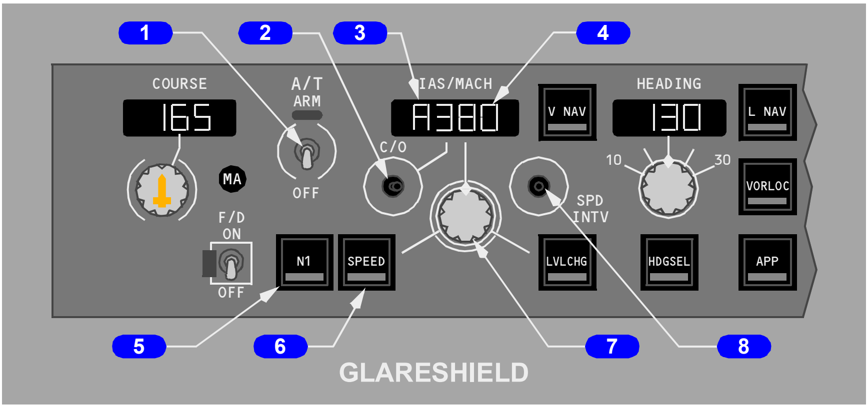
Mode Control Panel (MCP)

Speed Controls



1 Autothrottle (A/T) ARM Switch

ARM – Arms A/T for engagement. Magnetically held at ARM. A/T engages automatically when following AFDS modes are engaged:

- LVL CHG
- ALT ACQ
- V/S
- VNAV
- ALT HOLD
- G/S capture
- TO/GA.

The indicator light illuminates green when A/T ARM switch is in the ARM position.

OFF – disengages A/T and prevents A/T engagement.

2 Changeover (C/O) Switch

Push –

- changes IAS/MACH display between IAS and MACH
- automatic changeover occurs at approximately FL260.

3 MCP Speed Condition Symbols

Overspeed or underspeed limiting symbol appears when commanded speed cannot be reached.

Underspeed limiting (flashing character “A”) – minimum speed

Overspeed limiting (flashing character “8”) –

- Vmo or Mmo limit
- landing gear limit
- flap limit.

4 IAS/MACH Display

Displays speed selected by IAS/MACH selector

- display is blank when:
  - VNAV mode engaged
  - A/T engaged in FMC SPD mode
  - during 2 engine AFDS go–around.
- displays 100 knots when power is first applied
- display range is:
  - 100 KIAS – Vmo in 1 knot increments
  - .60M – Mmo in .01M increments.

5 N1 Switch

Push – (light not illuminated)

- engages A/T in N1 mode if compatible with AFDS modes already engaged
- illuminates N1 switch light
- annunciates N1 autothrottle mode.

Push – (light illuminated)

- deselects N1 mode and extinguishes switch light
- engages autothrottles in ARM mode.

N1 Mode

- A/T maintains thrust at N1 limit selected from FMC CDU. N1 mode engaged manually by pushing N1 switch if N1 mode is compatible with existing AFDS modes. N1 mode engages automatically when:
  - engaging LVL CHG in climb (except during inhibit period for 2 1/2 minutes after lift-off)
  - engaging VNAV in climb.

6 SPEED Switch

Push – (light not illuminated)

- engages A/T in SPEED mode if compatible with engaged AFDS modes
- illuminates SPEED switch light
- annunciates MCP SPD autothrottle mode
- maintains speed in MCP IAS/MACH display.

Push – (light illuminated)

- deselects speed mode and extinguishes switch light
- engages A/T in ARM mode.

Speed Mode

Autothrottle holds speed in IAS/MACH display or a performance or limit speed. Speed mode engaged manually by pushing SPEED switch if speed mode is compatible with existing AFDS modes. Speed mode engages automatically when:

- ALT ACQ engages
- ALT HOLD engages
- V/S engages
- G/S capture occurs.

When the “N1 SET” outer knob is in the AUTO position the A/T will not set thrust above the displayed N1 limit, however, A/T can exceed an N1 value manually set with the “N1 SET” outer knob in the manual BOTH, 1, or 2 position. Setting the thrust reference manually is intended to provide guidance when manually controlling thrust.

7 IAS/MACH Selector

Rotate –

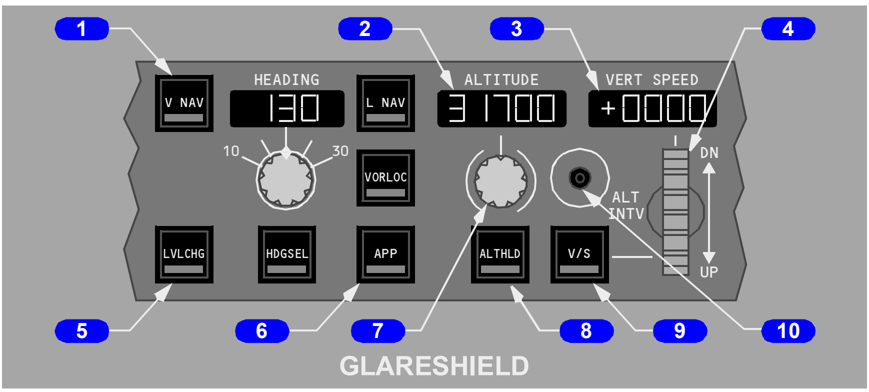
- sets speed in IAS/MACH display and positions airspeed cursor
- selected speed is reference speed for AFDS and A/T
- not operative when IAS/MACH display is blank.

8 **Speed Intervention (SPD INTV) Switch**

Push (when VNAV engaged) –

- IAS/MACH display alternately shows selected IAS/Mach and blanks
- when IAS/MACH display is unblanked, FMC speed intervention is active, FMC target speed is displayed, and IAS/MACH Selector may be used to set desired speed
- when IAS/MACH display is blank, FMC computed target speed is active and displayed on the airspeed indicator.

Vertical Navigation



1 **VNAV Switch**

Push –

- VNAV switch light illuminates
- pitch mode annunciates VNAV SPD, VNAV PTH, or VNAV ALT
- A/T mode annunciates FMC SPD, N1, RETARD, or ARM
- IAS/MACH display blanks and airspeed cursors positioned to FMC commanded airspeed.

VNAV Mode

The FMC commands AFDS pitch and autothrottle to fly vertical profile selected on FMC CDUs. Profile includes climb, cruise, descent, speeds, and can also include waypoint altitude constraints.

VNAV arm criteria on the ground:

- a valid flight plan has been entered
- performance data has been entered and executed
- both flight director switches have been turned on
- VNAV guidance becomes active at 400 feet AGL.

Climb –

- autothrottle holds FMC thrust limit
- AFDS holds FMC target speed
- automatic level-off occurs at MCP altitude or VNAV altitude, whichever is reached first
  - MCP constrained altitude annunciates VNAV ALT
  - VNAV constrained altitude annunciates VNAV PTH.

Cruise –

- autothrottle holds FMC target speed
- AFDS holds FMC altitude
- selecting a lower MCP altitude arms FMC to automatically begin descent upon arrival at FMC top of descent point.

Descent –

- VNAV SPD descent
  - autothrottle holds idle
  - AFDS holds FMC target speed.
- VNAV PTH descent
  - autothrottle holds idle but can command FMC SPD mode if ground speed becomes too low to maintain FMC vertical path
  - AFDS tracks FMC descent path.
- automatic level-off occurs at MCP altitude or VNAV altitude, whichever is reached first
  - MCP constrained altitude annunciates VNAV ALT
  - VNAV constrained altitude annunciates VNAV PTH.

Inhibited below 400 ft RA or if performance initialization not complete.

VNAV mode is terminated by any one of the following:

- selecting another pitch mode
- glideslope capture
- reaching end of LNAV route
- transition of glideslope intercept waypoint if G/S is armed
- crosstrack deviation exceeds twice the RNP value during PTH descent for an active leg with a database vertical angle and LNAV not engaged.

In the event of glideslope intercept waypoint transition, VNAV can be re-engaged.

2 ALTITUDE Display

Displays selected altitude

- displayed altitude is reference for altitude alerting and automatic level–offs
- altitude range is 0 to 50,000 feet in 100 foot increments
- displays previously selected altitude when power first applied.

3 Vertical Speed (VERT SPEED) Display

Displays:

- blank when V/S mode not active
- present V/S when V/S mode is engaged with V/S switch
- selected V/S when V/S set with thumbwheel
- range is –7900 to +6000 fpm.

Display increments are:

- 50 fpm if V/S is less than 1000 fpm
- 100 fpm if V/S is 1000 fpm or greater.

4 Vertical Speed Thumbwheel

Rotate –

- DN –
  - sets vertical speed in VERT SPEED display
  - increases rate of descent or reduces rate of ascent.
- UP –
  - sets vertical speed in VERT SPEED display
  - increases rate of ascent or reduces rate of descent.

5 Level Change (LVL CHG) Switch

Push –

- LVL CHG switch light illuminates
- pitch mode annunciates MCP SPD for climb or descent
- autothrottle mode annunciates N1 for climb and RETARD followed by ARM for descent
- IAS/MACH display and airspeed cursors display target speed.

LVL CHG Mode

The LVL CHG mode coordinates pitch and thrust commands to make automatic climbs and descents to preselected altitudes at selected airspeeds.

A LVL CHG climb or descent is initiated by:

- selecting a new altitude
- pushing LVL CHG switch
- setting desired airspeed.

Climb –

- autothrottle holds limit thrust
- AFDS holds selected airspeed.

Descent –

- autothrottle holds idle thrust
- AFDS holds selected airspeed.

Airspeed –

- if a speed mode is active when LVL CHG is engaged, this speed is retained as target speed
- if a speed mode is not active when LVL CHG is engaged, existing speed becomes target speed
- speed can be changed with MCP IAS/MACH Selector.

The LVL CHG mode is inhibited after glideslope capture.

6 Approach (APP) Switch

(See Lateral Navigation)

7 Altitude Selector (SEL)

Rotate –

- sets altitude in ALTITUDE display in 100 foot increments
- arms V/S mode if rotated while in ALT HOLD at selected altitude.

8 Altitude Hold (ALT HLD) Switch

Push –

- engages ALT HOLD command mode
- commands pitch to hold uncorrected barometric altitude at which switch was pressed
- annunciates ALT HOLD pitch mode and illuminates ALT HLD switch light.

Altitude Hold Command Mode

ALT HOLD mode commands pitch to hold either:

- MCP selected altitude
  - pitch mode annunciates ALT HOLD
  - ALT HLD switch light extinguishes.

- uncorrected barometric altitude at which ALT HLD switch was pressed if not at MCP selected altitude
  - •pitch mode annunciates ALT HOLD
  - •ALT HLD switch light illuminates.

When in ALT HOLD at selected MCP altitude:

- selecting a new MCP altitude illuminates the ALT HLD switch light and arms V/S mode
- LVL CHG, V/S, and VNAV climb and descent functions are inhibited until a new MCP altitude is selected.

ALT HOLD mode is inhibited after G/S capture.

The selected MCP altitude is referenced to:

- Captain's barometric altimeter setting for A A/P and F/D
- First Officer's barometric altimeter setting for B A/P and F/D.

Note: After ALT HOLD engages, changes in altimeter barometric settings do not change the selected altitude reference.

9 Vertical Speed (V/S) Switch

Push –

- arms or engages V/S command mode
- commands pitch to hold vertical speed
- engages A/T in speed mode to hold selected airspeed
- annunciates V/S pitch mode and illuminates V/S switch light.

Vertical Speed Command Mode

The V/S mode commands pitch to hold selected vertical speed and engages A/T in SPEED mode to hold selected airspeed. V/S mode has both an armed and an engaged state.

Engaged –

- annunciates V/S pitch mode
- vertical speed display changes from blank to present vertical speed
- desired vertical speeds can be selected with vertical speed thumbwheel.

V/S becomes armed if:

- pitch mode is ALT HLD at selected MCP altitude and
- new MCP altitude is selected (more than 100 feet from current altitude).

With V/S armed, V/S mode is engaged by moving vertical speed thumbwheel.

V/S mode automatically engages if ALT ACQ mode is engaged and a new MCP altitude is selected which is more than 100 feet different from previously selected altitude.

- vertical speeds can be selected which command flight toward or away from selected altitude.

Inhibited if:

- ALT HOLD mode is active at selected MCP altitude
- glideslope captured in APP mode.

10 Altitude Intervention (ALT INTV) Switch

Allows manual deletion of next FMC altitude constraint via altitude SEL and ALT INTV switch.

Push – (during VNAV climb)

- lowest FMC altitude constraint below selected MCP altitude is deleted
- if airplane is currently at an FMC altitude constraint, deletion allows airplane to resume climb. MCP altitude must be set above current altitude
- for each press of switch, one deletion occurs
- if MCP altitude is set above current FMC altitude, FMC cruise altitude resets to MCP altitude. FMC cruise altitude cannot be decreased using ALT INTV switch.

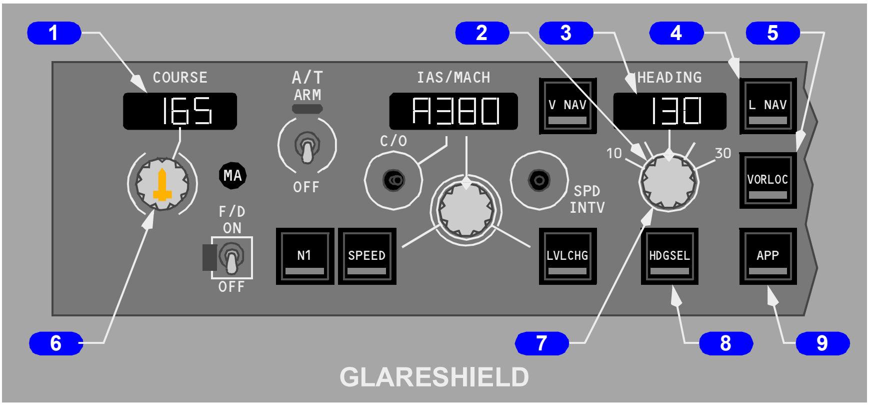
Push – (during VNAV cruise)

- if MCP altitude is set above current FMC cruise altitude, FMC resets cruise altitude to MCP altitude and initiates a cruise climb
- if an MCP ALT is set to a lower altitude, but at or above any descent constraint, a CRZ DES occurs if the airplane is further than 50 nm from the top of descent at the current cruise altitude. The result will be a cruise altitude reset to the MCP ALT and vertical speed commands of -1000 fpm to the new cruise altitude. If within 50 nm of the top of descent, the Early Descent mode will be invoked.
- if more than 50 NM to T/D with VNAV engaged and the MCP ALT below current altitude and below a descent constraint altitude, the result will be Early Descent vertical speed commands of -1000 fpm until path intercept or MCP ALT level off occurs.

Push – (during VNAV descent)

- the highest FMC altitude constraint above MCP altitude is deleted
- if airplane is currently at an FMC altitude constraint, deletion allows airplane to continue descent. MCP altitude must be set below current altitude
- if all FMC altitude constraints are deleted during VNAV path descent, an automatic transition to a VNAV speed descent is made.

Lateral Navigation



1 COURSE Display

Displays course set by course selector.

Note: Different courses and frequencies on two VHF NAV receivers can cause disagreement between Captain and FO F/D displays and affect A/P operation.

2 Heading Selector

Rotate –

- sets heading in HEADING display
- positions selected heading bugs on the DUs.

3 HEADING Display

Displays selected heading.

4 LNAV Switch

Push –

- commands AFDS roll to intercept and track the active FMC route
- annunciates LNAV as roll mode and illuminates LNAV switch light.

LNAV Mode

In LNAV mode, the FMC controls AFDS roll to intercept and track active FMC route. Active route is entered and modified through FMC CDUs and can include SIDs, STARs, and instrument approaches.

LNAV arming criteria on the ground:

- origin runway in flight plan
- active route entered in FMC
- track of first leg within 5 degrees of runway heading
- both flight director switches have been switched on
- LNAV selected prior to TO/GA.
  - LNAV guidance becomes active at 50 feet AGL
  - bank angle is limited to 8 degrees below 200 feet and 30 degrees above 200 feet AGL.

LNAV engagement criteria in flight:

- active route entered in FMC
- within 3 NM of active route, LNAV engagement occurs with any airplane heading
- outside of 3 NM, airplane must:
  - be on intercept course of 90 degrees or less
  - intercept route segment before active waypoint.

LNAV automatically disconnects for following reasons:

- reaching end of active route
- reaching a route discontinuity
- intercepting a selected approach course in VOR LOC or APP modes (VOR/LOC armed)
- selecting HDG SEL
- loss of capture criteria.

5 VOR Localizer (LOC) Switch

Push –

- commands AFDS roll to capture and track selected VOR or LOC course
- annunciates VOR/LOC armed or engaged as roll mode and illuminates VOR LOC switch light.

VOR LOC Mode

Pushing the VOR LOC switch selects VOR mode if a VOR frequency is tuned or selects LOC mode if a localizer frequency is tuned.

The VOR mode provides roll commands to track selected VOR course.

The LOC mode provides roll commands to track selected localizer course along inbound front course bearing.

The selected course can be intercepted while engaged in:

- LNAV
- HDG SEL
- CWS R if an autopilot is engaged in CMD.

The capture point is variable and depends on intercept angle and closure rate. Localizer capture occurs not later than 1/2 dot deviation. Course capture is indicated when VOR/LOC annunciation changes from armed to engaged.

While engaged in VOR or LOC modes:

- A autopilot and Captain's F/D use information from Captain's course selector and No. 1 VHF NAV receiver
- B autopilot and First Officer's F/D use information from First Officer's course selector and No. 2 VHF NAV receiver
- different courses and/or frequencies for two VHF NAV receivers can cause disagreement between the Captain's and First Officer's F/D displays and affect A/P operation.

Note: When a localizer frequency is selected, VHF NAV radios automatically switch from tail antenna to nose antenna when VOR/LOC is annunciated (armed or engaged). If antenna switching does not occur, LOC mode is inhibited.

Note: Localizer backcourse tracking is not available.

6 Course Selector

Sets course in COURSE display for related VHF NAV receiver, AFDS and DU. Two course selectors and COURSE displays are located on the MCP.

Rotate Captain's course selector – provides selected course information to:

- A FCC
- No. 1 VHF NAV receiver
- Captain's course pointer and course deviation bar.

Note: In VOR LOC or APP mode, the A A/P and Captain's F/D use selected course and navigation data from the No. 1 VHF NAV receiver.

Rotate First Officer's course selector – provides selected course information to:

- B FCC
- No. 2 VHF NAV receiver
- First Officer's course pointer and course deviation bar.

Note: In VOR LOC or APP mode, B A/P and First Officer's F/D use selected course and navigation data from No. 2 VHF NAV receiver.

7 Bank Angle Selector

Rotate –

- sets maximum bank angle for AFDS operation in HDG SEL or VOR modes
- commanded bank angle can be selected at 10, 15, 20, 25, or 30 degrees.

8 Heading Select (HDG SEL) Switch

Push –

- engages HDG SEL command mode
- commands roll to follow selected heading
- annunciates HDG SEL as FMA roll mode and illuminates HDG SEL switch light.

Heading Select Command Mode

The HDG SEL mode commands roll to turn to and maintain heading shown in MCP HEADING display:

- initial selection commands turn in shortest direction toward selected heading bug
- after mode engagement, roll commands are given to turn in same direction as rotation of heading selector
- bank angle limit is established by bank angle selector
- HDG SEL mode automatically disengages upon capture of selected radio course in VOR LOC and APP modes (VOR/LOC armed).

9 Approach (APP) Switch

Push –

- illuminates APP switch light
- arms the AFDS for localizer/final approach course and glideslope/glidepath capture
- roll mode annunciates VOR/LOC/FAC armed
- pitch mode annunciates G/S or G/P armed (as installed)
- enables engagement of both autopilots.

APP Mode

The approach mode arms AFDS to capture and track localizer and glideslope and can be engaged for dual or single autopilot operation.

One VHF NAV receiver must be tuned to an ILS frequency before approach mode can be engaged. With one VHF NAV receiver tuned, onside AFDS is enabled for guidance and operation.

For dual autopilot operation, both VHF NAV receivers must be tuned to the ILS frequency and both autopilots must be selected in CMD prior to 800 feet RA.

APP mode operation:

- localizer must be captured prior to glideslope
- localizer can be intercepted in HDG SEL, LNAV, or CWS R

- SINGLE CH annunciates in A/P Status Display after localizer capture
  - for single autopilot approach, SINGLE CH remains annunciated for entire approach
  - for dual autopilot approach, SINGLE CH annunciation extinguishes when second autopilot engages and ROLLOUT (as installed) armed and FLARE armed are annunciated
- glideslope capture occurs at 2/5 dot below glideslope
- APP switch light extinguishes after localizer and glideslope capture.

After localizer and glideslope capture, APP mode can be disengaged by:

- pushing a TO/GA switch
- disengaging autopilot(s) and turning off both F/D switches
- retuning the VHF NAV receiver.

While engaged in the APP mode:

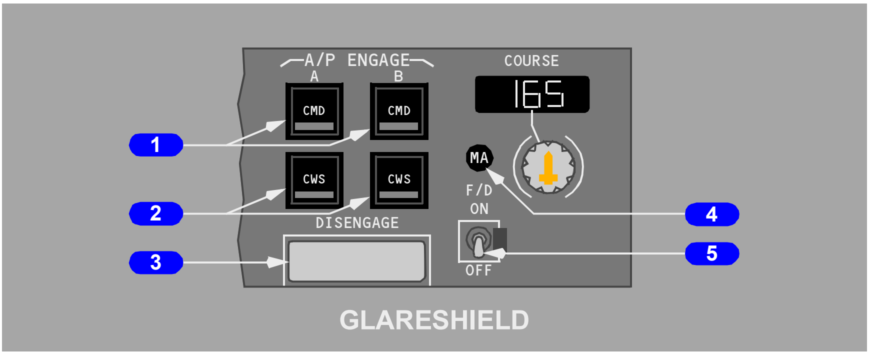
- the A autopilot and Captain's F/D use information from Captain's Course Selector and No. 1 VHF NAV receiver
- the B autopilot and First Officer's F/D use information from First Officer's Course Selector and No. 2 VHF NAV receiver
- different courses and/or frequencies for the two VHF NAV receivers can cause disagreement between Captain's and First Officer's F/D displays and affect A/P operation.

Note: After localizer or glideslope capture, during a single channel autopilot approach, CWS cannot be engaged by manually overriding pitch and/or roll control forces. Manually overriding pitch and/or roll will cause autopilot disengage. At autopilot disengage, the active Autopilot modes will remain engaged.

Note: During a dual autopilot approach and after FLARE ARM annunciation, any attempted manual override of the autopilots may result in an autopilot disengage.

Autopilot / Flight Director

Pushing a CMD or CWS switch engages related A/P in CMD or CWS and illuminates switch lights. A/P can operate in CMD, CWS, or a combination of CMD and CWS.



1 Command Engage (CMD ENGAGE) Switch (A or B):

Push –

- engages A/P
- enables all command modes
- displays CMD in A/P status display
- pushing an engage switch for second A/P, while not in approach mode, engages second A/P and disengages first A/P
- enables CWS operation
- CWS engages if:
  - •pitch or roll mode not selected
  - •pitch or roll mode deselected.
- CWS engaged displays:
  - •CWS P and/or CWS R in A/P status display
  - •blank in pitch and/or roll mode FMA.
- when approaching a selected altitude in CWS P, the pitch mode engages in ALT ACQ and ALT HOLD when reaching selected altitude
- when approaching a selected radio course in CWS R with VOR/LOC or approach mode armed, VOR/LOC engages when course is intercepted.

Note: During F/D only operation, while a pitch command is more than 1/2 scale from center, pushing a CMD A or B switch engages the A/P in CWS for pitch and the related F/D bar(s) retract.

2 Control Wheel Steering Engage (CWS ENGAGE) Switch (A or B):

Push –

- engages A/P
- engages pitch and roll modes in CWS. Other pitch and roll modes not enabled
- displays CWS P and CWS R in A/P status display
- CMD not displayed in A/P status display
- F/Ds, if ON, display guidance commands and FD annunciates in A/P status display. A/P does not follow commands while in CWS
- A/P pitch and roll controlled by pilot with control wheel pressure
- when control pressure released, A/P holds existing attitude. If aileron pressure released with 6 degrees or less bank, the A/P rolls wings level and holds existing heading. Heading hold feature inhibited:
  - below 1500 feet RA with gear down
  - after LOC capture in APP mode
  - after VOR capture with TAS 250 knots or less.

3 Autopilot Disengage (DISENGAGE) Bar

Pull down –

- exposes yellow background
- disengages both A/Ps
- prevents A/P engagement.

Lift up –

- conceals yellow background
- enables A/P engagement.

4 Master (MA) Flight Director Indicators (white letters)

If a F/D switch is ON, the light indicates which FCC is controlling the F/D modes.

- illuminated – related FCC is controlling F/D modes
- extinguished – F/D modes are controlled from opposite FCC
- both lights illuminated – each FCC is controlling modes for related F/D.

5 Flight Director (F/D) Switch

Left F/D switch activates command bars on the Captain's attitude indicator. Right F/D switch activates command bars on the First Officer's attitude indicator.

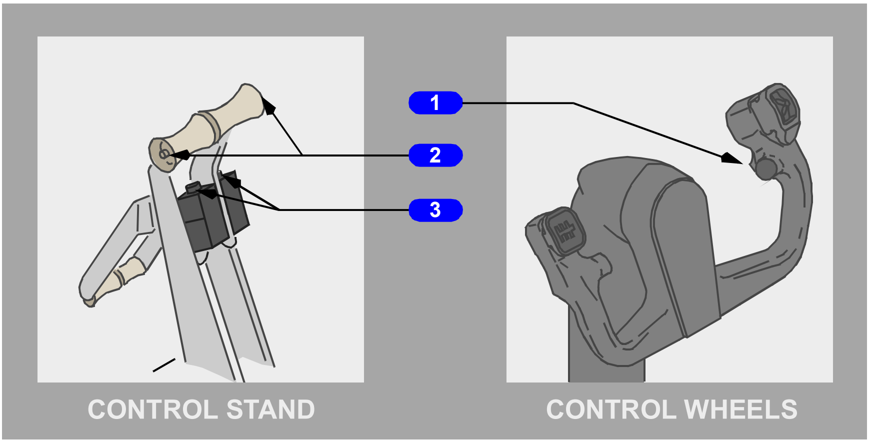
ON –

- in flight with A/P ON and F/Ds OFF, turning a F/D switch ON engages F/D in currently selected A/P modes
- displays FD in A/P status display if A/P is OFF or engaged in CWS
- enables command bar display on related pilot's attitude indicator

- command bars are displayed if command pitch and/or roll modes are engaged
- on ground, arms pitch and roll modes for engagement in TO/GA and wings level when TO/GA switch is pushed.

OFF – command bars retract from related pilot's attitude indicator.

Autopilot / Autothrottle Controls



1 Autopilot Disengage Switch

Push –

- disengages both autopilots
- A/P disengage lights flash
- A/P disengage warning tone sounds for a minimum of two seconds
- second push extinguishes disengage lights and silences disengage warning tone
- if autopilot automatically disengages, extinguishes A/P Disengage lights and silences A/P warning tone.

2 Autothrottle Disengage Switches

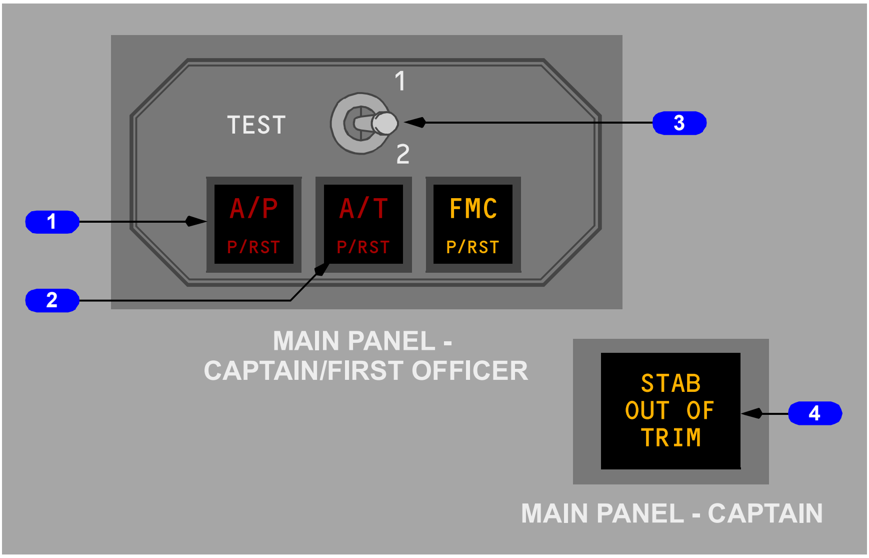
Push –

- disengages autothrottle
- A/T disengage lights flash
- A/T ARM switch trips OFF
- second press extinguishes A/T disengage lights
- extinguishes A/T disengage lights after automatic A/T disengagement.

3 Takeoff/Go–Around (TO/GA) Switches

Push – engages AFDS and A/T in takeoff or go–around mode if previously armed.

Autopilot / Autothrottle Indicators



1 Autopilot (A/P) Disengage Light

Illuminated (red) –

- flashes and tone sounds when autopilot has disengaged
- flashes and tone sounds when an autopilot engage attempt is made and is unsuccessful
- reset by pushing either disengage light or either A/P disengage switch
- steady for any of following conditions:
  - stabilizer out of trim below 800 feet RA on dual channel approach
  - ALT ACQ mode inhibited during A/P go–around if stabilizer not trimmed for single A/P operation
  - disengage light test switch held in position 2
  - automatic ground system tests fail.

Illuminated (amber) –

- steady – disengage light test switch held in position 1
- flashing – A/P automatically reverts to CWS pitch or roll while in CMD. Resets by pushing either light or selecting another mode
- steady – with disengage light test switch not held in position 1, indicates a downgrade in autoland capability.

2 Autothrottle (A/T) Disengage Light

Illuminated (red) –

- flashing – autothrottle has disengaged
- steady – disengage light test switch held in position 2.

Illuminated (amber) –

- steady – disengage light test switch held in position 1
- flashing – indicates A/T airspeed error under following conditions:
  - inflight
  - flaps not up
  - airspeed differs from commanded value by +10 or -5 knots and is not approaching commanded value.

3 Disengage Light Test (TEST) Switch

TEST 1 – illuminates autopilot/autothrottle disengage and FMC alert lights steady amber.

TEST 2 – illuminates autopilot/autothrottle disengage lights steady red and FMC alert light steady amber.

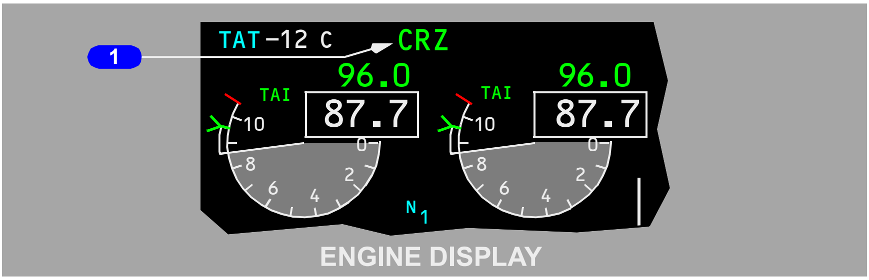
Spring–loaded to center position.

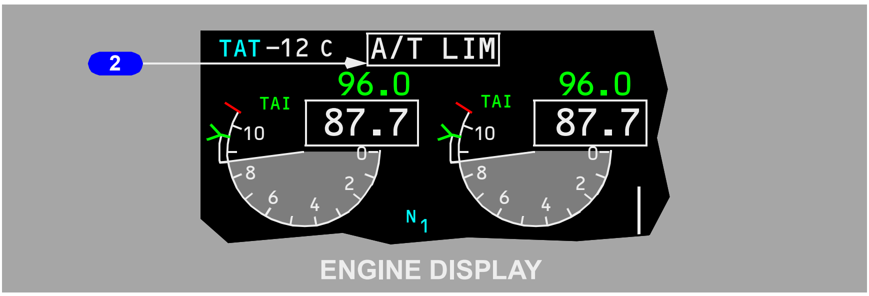
4 Stabilizer Out Of Trim (STAB OUT OF TRIM) Light

Illuminated (amber) –

- In-flight
  - autopilot is not properly trimming the stabilizer
  - partial failure of a Flight Control Computer
  - illuminates only with autopilot engaged. Remains extinguished when the autopilot is not engaged.
- On the ground
  - partial failure of a Flight Control Computer
  - illuminates after landing when groundspeed is less than 30 knots.

Thrust Mode Display





1 Thrust Mode Display

N1 limit reference is the active N1 limit for autothrottle and manual thrust control.

N1 limit reference is also displayed by N1 reference bugs with N1 SET control in AUTO position.

N1 limit reference is normally calculated by the FMC.

Thrust mode display annunciations are:

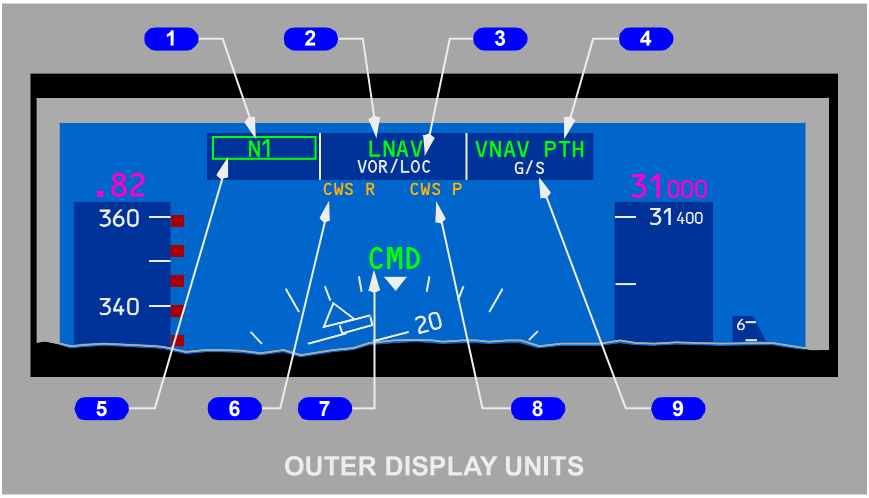
- TO – takeoff
- TO 1 – derated takeoff one
- TO 2 – derated takeoff two
- D-TO – assumed temperature reduced thrust takeoff
- D-TO 1 – derate one and assumed temperature reduced thrust takeoff
- D-TO 2 – derate two and assumed temperature reduced thrust takeoff
- TO B – takeoff bump thrust
- CLB – climb
- CLB 1 – derated climb one
- CLB 2 – derated climb two
- CRZ – cruise
- MAN– manual N1 setting
- G/A – go–around

- CON – continuous
- —— – FMC not computing thrust limit.

2 **Autothrottle Limit (A/T LIM) Indication**

Illuminated (white) – the FMC is not providing the A/T system with N1 limit values. The A/T is using a degraded N1 thrust limit from the related EEC.

Flight Mode Annunciations (FMAs)



1 **Autothrottle (A/T) Engaged Mode**

- N1 (green)
- GA (green)
- RETARD (green)
- FMC SPD (green)
- MCP SPD (green)
- THR HLD (green)
- ARM (white)

2 **Roll Engaged Mode**

- HDG SEL (green)
- VOR/LOC (green)
- FAC (green)
- LNAV (green)
- ROLLOUT (green)
- B/CRS (green)

3 Roll Armed Mode

- VOR/LOC (white)
- LNAV VOR/LOC (white)
- LNAV (white)
- LNAV FAC (white) (as installed)
- LNAV B/CRS (white) (as installed)
- LNAV ROLLOUT (white) (as installed)
- FAC (white) (as installed)

4 Pitch Engaged Mode

- TO/GA (green)
- V/S (green)
- MCP SPD (green)
- ALT/ACQ (green)
- ALT HOLD (green)
- G/P (green) (as installed)
- G/S (green)
- FLARE (green)
- VNAV SPD (green)
- VNAV PTH (green)
- VNAV ALT (green)

5 Mode Change Highlight Symbol

A mode change highlight symbol (rectangle) is drawn around each pitch, roll, A/P status, and thrust engaged mode annunciation for a period of 10 seconds after each engagement. The mode highlight change symbol for CWS Mode annunciations (CWS R and CWS P) will flash for 10 seconds when CWS mode engages.

6 CWS Roll Engaged

- CWS R (amber)

7 Autopilot Status

- CMD (green)
- ▷LAND 2◁ (green) (as installed)
- SINGLE CH (amber)
- SINGLE CH (green-IAN) (as installed)
- FD (green)
- LAND 3 (green) (as installed)
- NO AUTOLAND (amber) (as installed)
- AUTOPILOT (amber) (as installed)

8 CWS Pitch Engaged

- CWS P (amber)

9 **Pitch Armed Mode**

- G/S (white)
- V/S (white)
- VNAV (white)
- G/P (white) (as installed)
- FLARE (white)
- G/S V/S (white)
- G/P V/S (white) (as installed)

Intentionally
Blank

General

The automatic flight system (AFS) consists of the autopilot flight director system (AFDS) and the autothrottle (A/T). The flight management computer (FMC) provides N1 limits and target N1 for the A/T and command airspeeds for the A/T and AFDS.

The AFDS and A/T are controlled using the AFDS mode control panel (MCP) and the FMC. Normally, the AFDS and A/T are controlled automatically by the FMC to fly an optimized lateral and vertical flight path through climb, cruise and descent.

AFS mode status is displayed on the flight mode annunciation on each pilot's primary display.

Autopilot Flight Director System (AFDS)

The AFDS is a dual system consisting of two individual flight control computers (FCCs) and a single mode control panel.

The two FCCs are identified as A and B. For A/P operation, they send control commands to their respective pitch and roll hydraulic servos, which operate the flight controls through two separate hydraulic systems.

For F/D operation, each FCC positions the F/D command bars on the respective attitude indicator.

MCP Mode Selector Switches

The mode selector switches are pushed to select desired command modes for the AFDS and A/T. The switch illuminates to indicate mode selection and that the mode can be deselected by pushing the switch again. While a mode is active, deselection can be automatically inhibited and is indicated by the switch being extinguished.

When engagement of a mode would conflict with current AFS operation, pushing the mode selector switch has no effect. All AFDS modes can be disengaged either by selecting another command mode or by disengaging the A/P and turning the F/Ds off.

Autopilot Engagement Criteria

Each A/P can be engaged by pushing a separate CMD or CWS engage switch. A/P engagement in CMD or CWS is inhibited unless both of the following pilot–controlled conditions are met:

- no force is being applied to the control wheel
- both the STAB TRIM PRI and STAB TRIM B/U cutout switches are in the NORMAL position.

Only one A/P can be engaged at a given time unless the approach (APP) mode is engaged. Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides control through landing flare and touchdown or an automatic go–around.

In single A/P operation, full automatic flare and touchdown capability and A/P go–around capability are not available.

Autopilot Disengagement

The A/P automatically disengages when any of the following occurs:

- pushing either A/P disengage switch
- column or wheel force override
- pushing either Takeoff/Go-around (TO/GA) switch with a single A/P engaged in CWS or CMD;
  - below 2000 feet RA, or
  - with flaps not up, or
  - G/S engaged.
- pushing either Takeoff/Go-around (TO/GA) switch with a single A/P engaged in CWS or CMD above 2000 feet RA with flaps not up or G/S engaged
- one second after activation of stick shaker if autopilot is engaged in ALT HOLD, VNAV ALT (as installed), VNAV PTH (in a level segment), VNAV PTH (flaps 15 or greater), V/S (flaps 15 or greater), G/P (as installed) or G/S (single channel only) modes. Refer to the Flight Director Display in this section for effects on flight director commands
- five minutes after continuous activation of stick shaker if not in any of the above modes
- five minutes after continuous stick shaker activation if the autopilot was re-engaged
- pushing either TO/GA switch after touchdown with both A/Ps engaged in CMD (except with LAND 3 or LAND 2 annunciated)
- pushing an illuminated A/P ENGAGE switch
- pushing the A/P DISENGAGE bar down

- activating either pilot's control wheel trim switch (except with LAND 3 or LAND 2 annunciated)
- moving either STAB TRIM PRI or the STAB TRIM B/U cutout switch to the CUTOUT position
- for a column and/or wheel force override of a single or dual channel CMD engaged autopilot, in approach or non-approach phase of flight. The AFDS will maintain the active pitch and roll modes with flight director guidance.
- either left or right IRS system failure or FAULT light illuminated
- loss of electrical power or a sensor input which prevents proper operation of the engaged A/P and mode
- loss of respective hydraulic system pressure.

Note: Loss of the system A engine-driven hydraulic pump, and a heavy demand on system A, may cause A/P A to disengage.

Note: During a LAND 3, LAND 3 fail-operational, or LAND 2 fail-passive landing with LAND 3 or LAND 2 annunciated, pressing TO/GA switch after touchdown or activating the manual electric trim will be ignored by both autopilot channels, both flight directors, and the autothrottle system. This ensures that inadvertent press of the TO/GA switch does not affect rollout.

AFS Failures

Power interruption or loss may cause disengagement of the AFDS and/or A/T. Re–engagement is possible after power is restored.

Dual channel A/P operation is possible only when two generators are powering the busses.

Two independent radio altimeters provide radio altitude to the respective FCCs. With a radio altimeter inoperative, the autopilot will disengage two seconds after LOC and GS capture.

Flight Director Display

Turning a F/D switch ON displays command bars on the respective pilot's attitude indicator if command pitch and roll modes are engaged. If command pitch and roll modes are not engaged, the F/D command bars do not appear. The F/Ds can be operated with or without the A/P and A/T. F/D command modes can be used with an A/P engaged in CWS.

F/D commands operate in the same command modes as the A/P except:

- the takeoff mode is a F/D only mode
- dual F/D guidance is available for single engine operation

- the F/D has no landing flare capability. F/D command bars retract from view at approximately 50 feet RA on an ILS approach.
- During a Fail Operational autoland flare with FLARE engaged and LAND 3 annunciated, F/D command bars center (as installed).

F/D commands are removed one second after activation of stick shaker for AFDS modes that do not have minimum speed reversion. The F/D command bars (both pitch and roll) return when airspeed increases to the top of the minimum maneuver speed (amber) bar. Refer to the Minimum Speed Reversion in this section for additional information.

Normally, FCC A drives the captain's command bars and FCC B drives the first officer's command bars. With both F/D switches ON, the logic for both pilots' F/D modes is controlled by the master FCC, and both FMA displays show the same mode status.

The master FCC is indicated by illumination of the respective master (MA) F/D indicator light. The master FCC is determined as follows:

- with neither A/P engaged in CMD, the FCC for the first F/D turned on is the master
- with one or both A/Ps engaged in CMD, the FCC for the first A/P in CMD is the master FCC, regardless of which F/D is turned on first.

F/D modes are controlled directly from the respective FCC under certain conditions. This independent F/D operation occurs when neither A/P is engaged in CMD, both F/D switches are ON and one of the following mode conditions exists:

- APP mode engaged with LOC and G/S captured
- GA mode engaged and below 400 feet RA
- TO mode engaged and below 400 feet RA.

For non-approach modes, if the pilot is flying manually but not following the flight director guidance in the roll mode and then selects autopilot CMD engagement, the autopilot will engage into the current flight director roll mode.

Independent F/D operation is indicated by illumination of both MA lights. When independent operation terminates, the MA light extinguishes on the slaved side.

If a generator is lost during a F/D TO or GA, or while in dual F/D APP mode below 800 feet, the FCC on the unaffected side positions the F/D command bars on both attitude indicators. If the F/D MA light on the affected side had been illuminated, it extinguishes upon electrical bus transfer.

AFDS Status Annunciation

The following AFDS status annunciations are displayed in the A/P status display located above the attitude indicator on the outboard display unit:

- CMD (one or both autopilots are engaged)
- FD (the flight director is ON and the autopilot is either OFF or engaged in CWS)
- CWS P (pitch mode engaged in CWS)
- CWS R (roll mode engaged in CWS)
- SINGLE CH (for single A/P ILS approach, annunciates after localizer capture and remains on for entire approach. For dual A/P ILS approach, annunciates after localizer capture and extinguishes after pitch monitor confidence test is successfully completed).

Fail-Operational Autoland Status Annunciations

(as installed)

The following annunciations provide the flight crew with autoland system mode and status:

- LAND 3 – two autopilots, three inertial sources, and the associated sensors are operating normally for an automatic landing and rollout.
- LAND 2 – a failure has occurred above Alert Height and redundancy is reduced; but the autoland system is still capable of making an automatic landing and rollout.
- NO AUTOLAND – the system is unable to make an automatic landing.

With a LAND 3 (fail-operational) indication, the autoland system level of redundancy is such that a single fault cannot prevent the autopilot system from making an automatic landing.

With a LAND 2 (fail passive) indication, the level of redundancy is such that a single fault cannot cause a significant deviation from the flight path.

The NO AUTOLAND status is annunciated if a system failure has occurred. FLARE and ROLLOUT will not arm when NO AUTOLAND is annunciated.

An advisory message is displayed on the Engine Display for any fault which limits the capability of the automatic landing system. NO LAND 3 indicates the autoland system does not have the required redundancy for LAND 3 operations. NO AUTOLAND indicates autoland is not available.

Should any single failure occur below Alert Height and the system is still capable of continuing the autoland and rollout, LAND 3 will remain displayed and the airplane will land and roll out normally without failure annunciation. Failure or autoland downgrade annunciations will then be displayed when the airplane has decelerated below 40 kts and the autopilots have been disengaged.

AFDS Flight Mode Annunciations

The flight mode annunciations are displayed just above the attitude indicator on the outboard display unit. The mode annunciations, from left to right, are:

- autothrottle
- roll
- pitch.

Engaged or captured modes are shown at the top of the flight mode annunciation boxes in large green letters. Armed modes are shown in smaller white letters at the bottom of the flight mode annunciation boxes.

Autothrottle Modes

- N1 – the autothrottle maintains thrust at the selected N1 limit displayed on the thrust mode display, including full go-around N1 limit
- GA – the autothrottle maintains thrust at reduced go–around setting
- RETARD – displayed while autothrottle moves thrust levers to the aft stop. RETARD mode is followed by ARM mode
- FMC SPD – the autothrottle maintains speed commanded by the FMC. The autothrottle is limited to the N1 value shown on the thrust mode display
- MCP SPD – the autothrottle maintains speed set in the MCP IAS/MACH display. The autothrottle is limited to the N1 value shown on the thrust mode display
- THR HLD – the thrust lever autothrottle servos are inhibited; the pilot can set the thrust levers manually
- ARM – no autothrottle mode engaged. The thrust lever autothrottle servos are inhibited; the pilot can set thrust levers manually. Minimum speed protection is provided

Pitch Modes

- TO/GA – Takeoff

  Engaged for takeoff by turning both F/D switches ON and pushing either TO/GA switch. Both F/Ds must be ON to engage TO/GA prior to starting takeoff.

  The AFDS commands pitch attitude in the following order:

  - 10 degrees nose down until 60 knots IAS
  - 15 degrees nose up after 60 knots IAS
  - 15 degrees nose up after lift–off until a sufficient climb rate is acquired. Then, pitch is commanded to maintain MCP speed plus 20 knots.

  TO/GA can also be engaged for takeoff with F/D switches OFF if a TO/GA switch is pushed after 80 knots IAS below 2000 feet AGL and prior to 150 seconds after lift–off.

- TO/GA – Go–around

  Engaged for go–around by pushing the TO/GA switch under the following conditions:

  •inflight below 2000 feet radio altitude

  •inflight above 2000 feet radio altitude with flaps not up or G/S captured

  •not in takeoff mode

  •either F/D ON or OFF.

  When engaged, the F/Ds command roll to hold the ground track, and 15 degrees nose up pitch. After reaching a programmed rate of climb, pitch commands the target airspeed for each flap setting based on maximum takeoff weight calculations.
- VNAV (armed) - displayed when VNAV is armed prior to takeoff. After takeoff, VNAV automatically engages at 400 feet AGL.
- VNAV (engaged) – VNAV is engaged by pushing the VNAV switch. With a VNAV mode engaged, the FMC commands AFDS pitch and A/T modes to fly the vertical profile

  •VNAV SPD – the AFDS maintains the FMC speed displayed on the airspeed indicator and/or the CDU CLIMB or DESCENT pages

  •VNAV PTH – the AFDS maintains FMC altitude or descent path with pitch commands.

  •VNAV ALT – when a conflict occurs between the VNAV profile and the MCP altitude, the airplane levels at the MCP altitude and the pitch flight mode annunciation becomes VNAV ALT. VNAV ALT maintains altitude.
- V/S (armed) – V/S mode can be engaged by moving Vertical Speed thumbwheel
- V/S (engaged) – commands pitch to hold selected vertical speed
- ALT ACQ – transition maneuver entered automatically from a V/S, LVL CHG, or VNAV climb or descent to selected MCP altitude. Engages but does not annunciate during VNAV transition
- ALT HOLD – commands pitch to hold MCP selected altitude or uncorrected barometric altitude at which ALT HOLD switch was pushed
- MCP SPD – pitch commands maintain IAS/MACH window airspeed or Mach
- G/S (armed) – the AFDS is armed for G/S capture
- G/S (engaged) – the AFDS follows the ILS glideslope
- G/P (armed) – the AFDS is armed for G/P capture (as installed)
- G/P (engaged) – the AFDS follows the IAN glide path (as installed)

- FLARE (armed) – during a dual A/P ILS approach, FLARE is displayed after LOC and G/S capture and below 1500 feet RA. The second A/P couples with the flight controls and A/P go–around mode arms
- FLARE (engaged) – during a dual A/P ILS approach, flare engages at 50 feet radio altitude. FLARE accomplishes the autoland flare maneuver.

Roll Modes

- LNAV (armed) – the AFDS is armed (prior to takeoff) to engage LNAV at 50 feet RA
- LNAV (armed) – in the approach phase and a missed approach exists in the flight plan
- LNAV (engaged) – the AFDS intercepts and tracks the active FMC route. Either of the following capture criteria must be met:
  - on any heading and within 3 NM of the active route segment
  - if outside of 3 NM of active route segment, airplane must be on an intercept course of 90 degrees or less and intercept the route segment before the active waypoint.
- HDG SEL – the airplane is turning to, or is on the heading selected in the MCP Heading Display
- VOR/LOC (armed) – AFDS is armed to capture selected VOR or LOC COURSE
- VOR/LOC (engaged) – AFDS tracks selected VOR course or tracks selected localizer course along the inbound front course bearing.
- FAC (armed) – the AFDS is armed to capture the IAN final approach course (as installed)
- FAC (engaged) – the AFDS tracks the IAN final approach course along the inbound course bearing (as installed).
- B/CRS (armed) – the AFDS is armed to capture the localizer final approach back course (as installed)
- B/CRS (engaged) – the AFDS tracks the localizer final approach course along the inbound back course bearing (as installed).
- ROLLOUT (armed) – annunciates below 1500 feet radio altitude (as installed).
- ROLLOUT (engaged) – at touchdown the AFDS uses rudder and nose wheel steering to keep the airplane on the localizer centerline (as installed).

Autopilot Control Wheel Steering

CWS Engage Switch Selected

Pushing a CWS engage switch engages the A/P pitch and roll axes in the CWS mode and displays CWS P and CWS R on the FMAs.

With CWS engaged, the A/P maneuvers the airplane in response to control pressures applied by either pilot. The control pressure is similar to that required for manual flight. When control pressure is released, the A/P holds existing attitude.

If aileron pressure is released with 6 degrees or less bank, the A/P rolls the wings level and holds existing heading. This heading hold feature with bank less than 6 degrees is inhibited when any of the following conditions exists:

- below 1,500 feet RA with the landing gear down
- after F/D VOR capture with TAS 250 knots or less
- after F/D LOC capture in the APP mode.

Pitch CWS with a CMD Engage Switch Selected

The pitch axis engages in CWS while the roll axis is in CMD when:

- a command pitch mode has not been selected or was deselected
- selecting CMD while not following a large deviation in the pitch flight director command.

CWS P is annunciated on the FMAs while this mode is engaged. Command pitch modes can then be selected.

When approaching a selected altitude in CWS P with a CMD engage switch selected, CWS P changes to ALT ACQ. When at the selected altitude, ALT HOLD engages.

Roll CWS with a CMD Engage Switch Selected

The roll axis engages in CWS while the pitch axis is in CMD when:

- a command roll mode has not been selected or was deselected
- flying beyond FMS end of route or into a route discontinuity.

CWS R is annunciated on the FMAs while this mode is engaged.

CWS R with a CMD engage switch illuminated can be used to capture a selected radio course while the VOR/LOC or APP mode is armed. Upon intercepting the radial or localizer, the F/D and A/P annunciations change from CWS R to VOR/LOC engaged, and the A/P tracks the selected course.

Autothrottle System

The A/T system provides automatic thrust control from the start of takeoff through climb, cruise, descent, approach and go–around or landing. In normal operation, the FMC provides the A/T system with N1 limit values.

The A/T moves the thrust levers with a separate servo motor on each thrust lever. Following manual positioning, the A/T may reposition the thrust levers to comply with computed thrust requirements except while in the THR HLD and ARM modes.

The A/T system operates properly with the EECs ON or in ALTN. In either case, the A/T uses the FMC N1 limits. During A/T operation, it is recommended that both EECs be ON or both be in ALTN, as this produces minimum thrust lever separation.

Autothrottle Engagement

Moving the A/T Arm switch to ARM, arms the A/T for engagement in the N1, MCP SPD or FMC SPD mode. The A/T Arm switch is magnetically held at ARM and releases to OFF when the A/T becomes disengaged.

A general summary of A/T mode engagement is as follows:

- A/T SPD or N1 modes automatically engage when AFDS command pitch modes become engaged
- engaging LVL CHG or VNAV climb modes automatically engages the A/T N1 mode
- engaging LVL CHG or VNAV descent modes automatically engages the A/T in RETARD and then ARM when thrust is at idle
- if not in a VNAV mode, engagement of ALT ACQ or ALT HOLD automatically engages the A/T in the MCP SPD mode; otherwise the A/T remains in FMC SPD
- engagement of G/S capture automatically engages the A/T in the MCP SPD mode
- alpha floor automatically engages the A/T when armed.

Autothrottle Disengagement

Any of the following conditions or actions disengages the A/T:

- moving the A/T Arm switch to OFF
- pushing either A/T Disengage switch
- an A/T system fault is detected
- two seconds have elapsed since landing touchdown.

The thrust levers should normally be aligned to no more than one full knob width difference during all ranges of normal operation with symmetrical thrust.

The autothrottle also disengages if it is engaged in a Speed mode, Retard for descent mode, or an N1 mode other than A/T GA mode AND;

- thrust levers become separated more than 10 degrees
- significant thrust difference along with control wheel roll input of 10 degrees or more at any point throughout the entire flight envelope

A/T disengagement is followed by A/T Arm switch releasing to OFF and flashing red A/T Disengage lights. The A/T Disengage lights do not illuminate when the A/T automatically disengages after landing touchdown.

Automatic Flight Operations

The phases of flight for automatic flight operations are:

- Takeoff and climb
- Enroute
- Approach and landing
- Go–around

Automatic Flight Takeoff and Climb

Takeoff is a flight director only function of the TO/GA mode. Flight director pitch and roll commands are displayed and the autothrottle maintains takeoff N1 thrust limit as selected from the FMC. The autopilot may be engaged after takeoff.

Both F/Ds must be ON to engage the takeoff mode prior to starting the takeoff. The F/D takeoff mode is engaged by pushing the TO/GA switch on either thrust lever. The FMAs display FD as the A/P status, TO/GA as the pitch mode, and HDG SEL (as installed) as the roll mode.

During takeoff, pushing a TO/GA switch engages the autothrottle in the N1 mode. The A/T annunciation changes from ARM to N1 and thrust levers advance toward takeoff thrust.

The F/D can also be engaged in the takeoff mode with the F/D switches off. If a TO/GA switch is pushed after 80 knots below 2000 feet AGL and prior to 150 seconds after lift–off, the F/D command bars automatically appear for both pilots.

During takeoff, prior to 60 KIAS:

- the pitch command is 10 degrees nose down
- the roll command is wings level or HDG SEL
- the autothrottle is engaged in the N1 mode
- thrust levers advance until the engines reach takeoff thrust
- the FMAs display N1 for the autothrottle mode, TO/GA for the pitch mode, and HDG SEL for the roll mode.

At 60 KIAS, the F/D pitch commands 15 degrees nose up.

At 84 KIAS, the A/T mode annunciates THR HLD.

At LIFT-OFF:

- the pitch command continues at 15 degrees until sufficient climb rate is acquired. Pitch then commands MCP speed (normally V2) plus 20 knots
- if an engine failure occurs on the ground, the pitch command target speed at lift-off is V2 or airspeed at lift-off, whichever is greater.
- the roll command maintains wings level or
- the roll command maintains HDG SEL. Bank angle is limited to 8 degrees below 400 feet, and 10–30 degrees selectable above 400 feet AGL.

After LIFT-OFF:

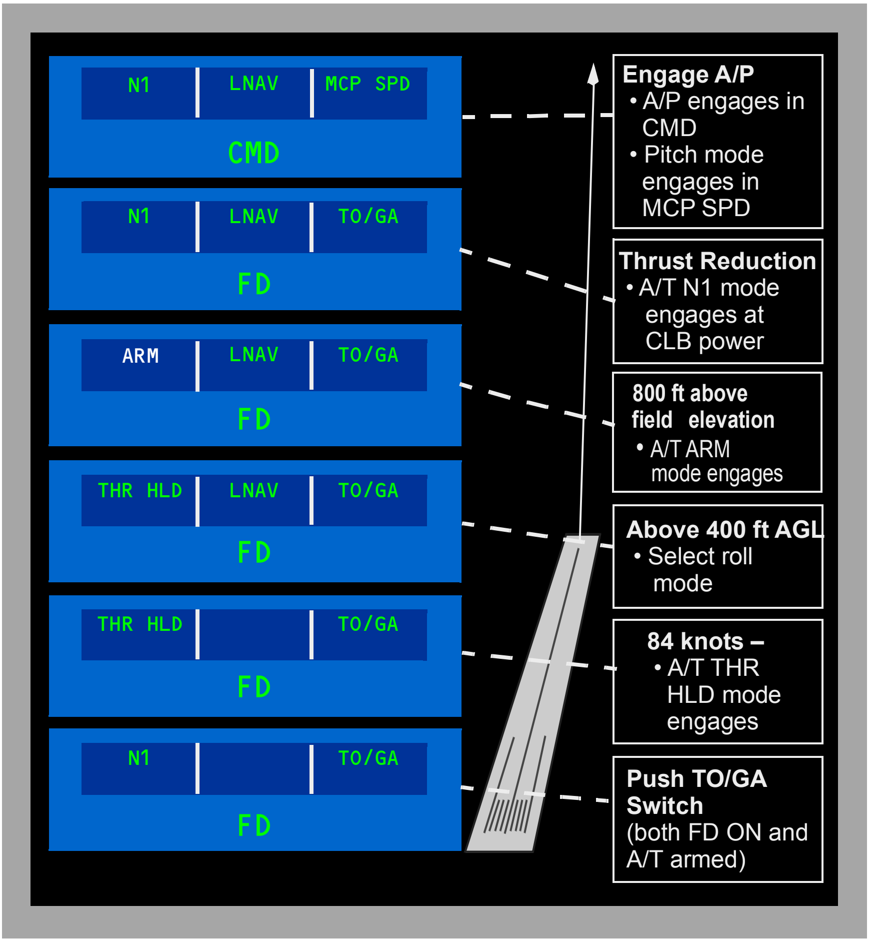
- if an engine failure occurs, the pitch command target speed is:
  - V2, if airspeed is below V2
  - existing speed, if airspeed is between V2 and V2 + 20
  - V2 + 20, if airspeed is above V2 + 20.
- the A/T remains in THR HLD until 800 feet above field elevation. A/T annunciation then changes from THR HLD to ARM and reduction to climb thrust can be made by pushing the N1 switch.

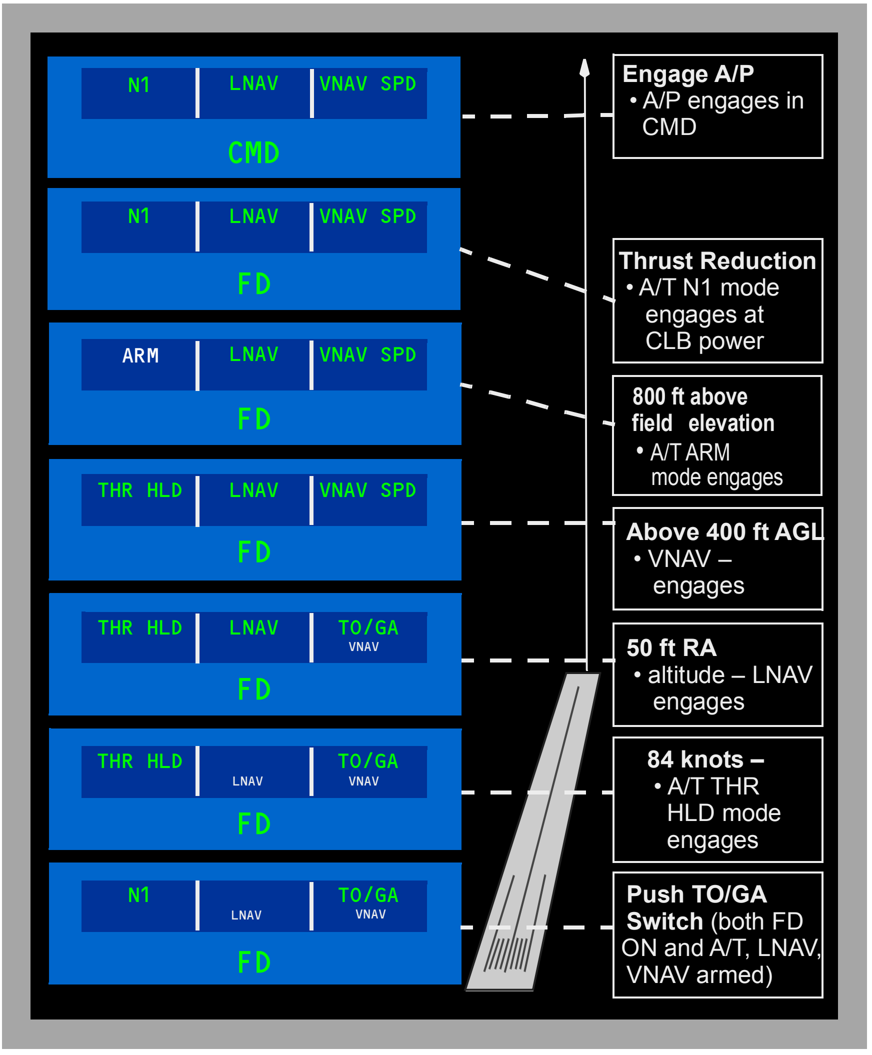
  Note: During a reduced thrust takeoff, a second press of the TO/GA switch below 800 feet above field elevation will change the thrust limit mode to GA and N1 reference bugs to increase to full GA thrust, thrust levers will not be in motion. A second press of the TO/GA switch above 800 feet above field elevation, thrust levers advance toward full GA thrust.

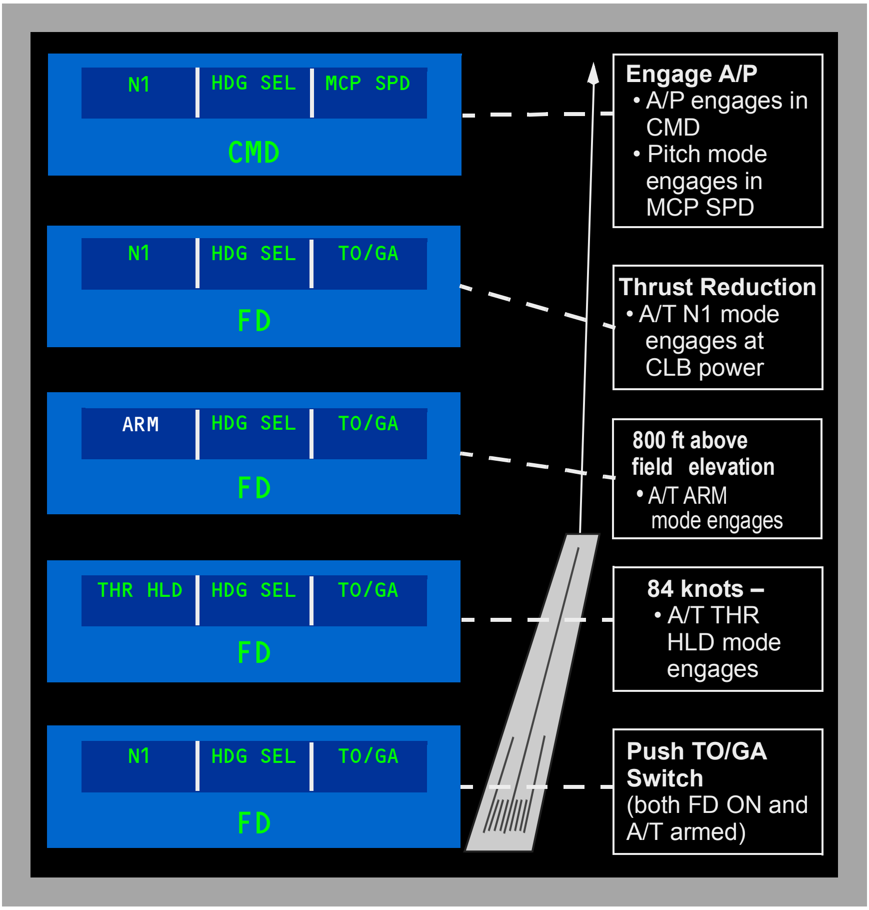
- automatic reduction to climb thrust occurs upon reaching the selected thrust reduction altitude which is shown on the FMC CDU TAKEOFF REF page 2/2 during preflight, or when the airplane levels off in ALT HOLD or VNAV PTH. Pilot entries can be made to override the default value. Allowable entries are 800 feet to 9999 feet.
- flight director engaged status is terminated by engaging an autopilot in CMD (CMD replaces FD in A/P status display)
  - pitch engages in LVL CHG and pitch mode FMA is MCP SPD unless another pitch mode has been selected
  - MCP IAS/Mach display and airspeed cursor change to V2 + 20 knots
  - roll mode engages in HDG SEL unless another roll mode has been selected.

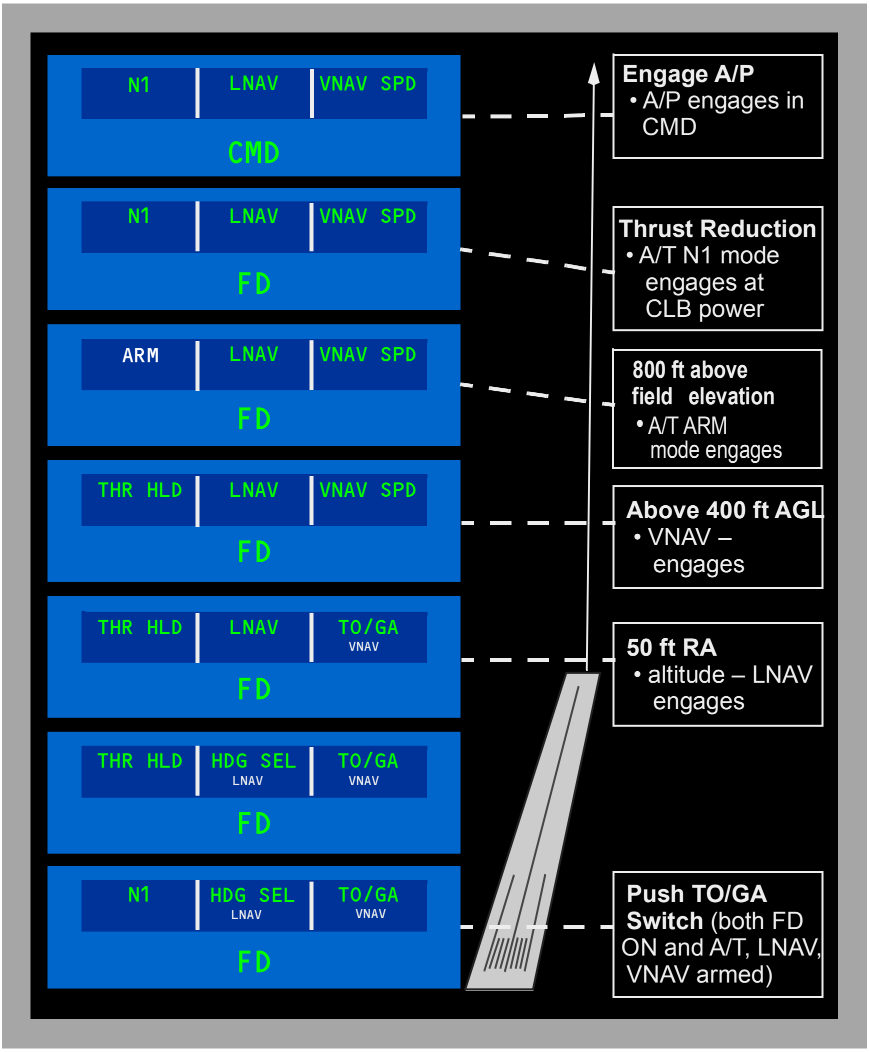
To terminate the takeoff mode below 400 feet AGL, both F/D switches must be turned OFF. At 400 feet AGL selection of another pitch mode or engaging an autopilot will terminate the takeoff mode; other F/D roll modes can be also selected.

Automatic Flight Takeoff Profile




N1
LNAV
VNAV SPD
CMD
N1
LNAV
VNAV SPD
FD
ARM
LNAV
VNAV SPD
FD
THR HLD
LNAV
VNAV SPD
FD
THR HLD
LNAV
TO/GA
VNAV
FD
THR HLD
LNAV
TO/GA
VNAV
FD
N1
LNAV
TO/GA
VNAV
FD
Engage A/P
• A/P engages in CMD
Thrust Reduction
• A/T N1 mode engages at CLB power
800 ft above field elevation
• A/T ARM mode engages
Above 400 ft AGL
• VNAV – engages
50 ft RA
• altitude – LNAV engages
84 knots –
• A/T THR HLD mode engages
Push TO/GA Switch (both FD ON and A/T, LNAV, VNAV armed)


N1
HDG SEL
MCP SPD
CMD
Engage A/P
• A/P engages in CMD
• Pitch mode engages in MCP SPD
N1
HDG SEL
TO/GA
FD
Thrust Reduction
• A/T N1 mode engages at CLB power
ARM
HDG SEL
TO/GA
FD
800 ft above field elevation
• A/T ARM mode engages
THR HLD
HDG SEL
TO/GA
FD
84 knots –
• A/T THR HLD mode engages
N1
HDG SEL
TO/GA
FD
Push TO/GA Switch
(both FD ON and A/T armed)



Automatic Flight En Route

The autopilot and/or the flight director can be used after takeoff to fly a lateral navigation track (LNAV) and a vertical navigation track (VNAV) provided by the FMC.

Other roll modes available are:

- VOR course (VOR/LOC)
- heading select (HDG SEL).

Other pitch modes available are:

- altitude hold (ALT HOLD)
- level change (MCP SPD)
- vertical speed (V/S).

Automatic Flight Approach and Landing

The AFDS provides guidance for single A/P non–precision approaches. The VOR/LOC switch arms the AFDS for VOR or localizer tracking. Descent may be accomplished using VNAV, LVL CHG, or V/S. VOR/LOC, LNAV, or HDG SEL may be used for the roll mode.

The AFDS provides guidance for single or dual A/P precision approaches. The approach mode arms the AFDS to capture and track the localizer and glideslope.

Approach (APP) Mode Dual A/Ps

Fail-Passive

Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides fail–passive operation through landing flare and touchdown or an automatic go–around. During fail passive operation, the flight controls respond to the A/P commanding the lesser control movement. If a failure occurs in one A/P, the failed channel is counteracted by the second channel such that both A/Ps disengage with minimal airplane maneuvering and with aural and visual warnings to the pilot.

Fail-Operational

Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides either fail–operational or fail–passive operation through landing flare, touchdown and rollout, or through an automatic go–around. If a failure is detected, the flight controls respond to the A/P commanding the lesser control movement. If a failure occurs in one A/P, the failed channel is counteracted by the second channel such that both A/Ps disengage with minimal airplane maneuvering and with aural and visual warnings to the pilot.

One VHF NAV receiver must be tuned to an ILS frequency before the approach mode can be selected. For a dual A/P approach, the second VHF NAV receiver must be tuned to the ILS frequency and the corresponding A/P engaged in CMD prior to 800 feet RA.

If the pilot is flying manually but not following the approach flight director guidance and then selects an autopilot CMD engagement, the autopilot reverts to CWS for the pitch and roll mode. The approach mode(s) will then re-arm.

Localizer and Glideslope Armed

After setting the localizer frequency and course, pushing the APP switch selects the APP mode. The APP switch illuminates and VOR/LOC and G/S annunciate armed. The APP mode permits selecting the second A/P to engage in CMD. This arms the second A/P for automatic engagement after LOC and G/S capture and when descent below 1500 RA occurs.

The localizer can be intercepted in the HDG SEL, CWS R or LNAV mode.

Glideslope (G/S) capture is inhibited prior to localizer capture.

Localizer Capture

The LOC capture point is variable and depends on intercept angle and rate of closure. Capture occurs no later than 1/2 dot. Upon LOC capture, VOR/LOC annunciates captured, SINGLE CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

Glideslope Capture

Glideslope capture is inhibited prior to localizer capture.

The G/S can be captured from above or below. Capture occurs at 2/5 dot and results in the following:

- G/S annunciates captured
- previous pitch mode disengages
- APP light extinguishes if localizer has also been captured
- airplane pitch tracks the G/S
- GA displayed on thrust mode display (N1 thrust limit).

After VOR/LOC and G/S are both captured, the APP mode can be exited by:

- pushing a TO/GA switch
- disengaging A/P and turning off both F/D switches
- retuning a VHF NAV receiver.

After LOC and G/S Capture

Shortly after capturing LOC or G/S and below 1500 feet RA:

- the second A/P couples with the flight controls
- test of the ILS deviation monitor system is performed and the G/S and LOC display turns amber and flashes
- test of autopilot rudder servo is performed
- FLARE armed is annunciated
- ROLLOUT armed is annunciated (as installed)

- the SINGLE CH annunciation extinguishes
- A/P go–around mode arms but is not annunciated.

Note: During a dual autopilot approach and after FLARE ARM annunciation, any attempted manual override of the autopilots may result in an autopilot disengage.

The A/Ps disengage and the F/D command bars retract to indicate an invalid ILS signal.

800 Feet Radio Altitude

The second A/P must be engaged in CMD by 800 feet RA to execute a dual channel A/P approach. Otherwise, CMD engagement of the second A/P is inhibited.

500 Feet Radio Altitude

(Fail-Operational)

The pilot is required to check for the presence of LAND 3 or LAND 2 in order to continue the autoland.

If the second autopilot in CMD remains armed and does not engage, LAND 2 or LAND 3 does not annunciate. Instead, the amber NO AUTOLAND annunciation alerts the pilot that dual control has not been established and the autoland is to be discontinued.

450 Feet Radio Altitude

(Fail-Operational)

The alignment mode is enabled which provides rudder compensation for the purpose of decreasing large crab angles produced by crosswinds, and to control the adverse moments caused by an engine failure. The automatic correction for aircraft crab angle due to crosswinds and engine failure enhances flight crew runway perspective and provides optimal aircraft position for initiation of rollout control. In a strong crosswind, the airplane does not fully align with the runway but lands in a slight crab. Sideslip is limited to 5 degrees. This mode is not annunciated.

400 Feet Radio Altitude

The stabilizer is automatically trimmed an additional amount nose up. If the A/Ps subsequently disengage, forward control column force may be required to hold the desired pitch attitude.

If FLARE is not armed by approximately 350 feet RA, both A/Ps automatically disengage.

Flare

The A/P flare maneuver starts at approximately 50 feet RA and is completed at touchdown:

- FLARE engaged is annunciated and with LAND 3 annunciated (as installed), F/D command bars center.
- the A/T begins retarding thrust at approximately 27 feet RA so as to reach idle at touchdown. A/T FMA annunciates RETARD.
- the A/T automatically disengages approximately 2 seconds after touchdown.
- the A/P must be manually disengaged after touchdown. Landing roll-out is executed manually after disengaging the A/P.

Rollout

(as installed)

ROLLOUT arms when LAND 2 or LAND 3 annunciates.

At approximately two feet radio altitude, rollout activates:

- ROLLOUT replaces the VOR/LOC roll flight mode annunciation
- the autopilot controls the rudder and nose wheel steering to keep the airplane on the localizer centerline
- rollout guidance continues until a full stop or until the autopilots are disengaged.

Approach (APP) Mode Single A/P

A single A/P ILS approach can be executed by engaging only one A/P in CMD after pushing the APP mode select switch. Single A/P approach operation is the same as dual, with the following exceptions:

- full automatic flare and touchdown capability is not available. FLARE is not annunciated and stabilizer trim bias is not applied
- if the pilot is flying manually but not following the approach flight director guidance and then selects an autopilot CMD engagement, the autopilot reverts to CWS for the pitch and/or roll mode. The approach mode(s) will then re-arm.
- A/P status of SINGLE CH is annunciated for the entire approach after localizer capture
- an A/P go–around is not available.
- after localizer or glideslope capture CWS cannot be engaged by manually overriding pitch and/or roll control forces. Manually overriding pitch and/or roll will cause autopilot disengage. At autopilot disengage, the active Autopilot modes will remain engaged.

ILS Beam Anomaly/Ground Station Failure Detection

For a single channel or F/D only approach, the autopilot will disengage and/or the F/D bars will be removed if a persistent localizer/glideslope beam anomaly or ground station failure is detected.

For a dual channel approach prior to annunciation of LAND 3 or LAND 2 (as installed), the autopilot will disengage and/or the F/D bars will be removed if a persistent localizer/glideslope beam anomaly or ground station failure is detected.

If a beam anomaly is detected after annunciation of LAND 3 or LAND 2, the appropriate localizer or glideslope deviation scale will turn amber and flash, the corresponding deviation pointer will flash, and a horizontal amber line will be drawn through the appropriate roll (VOR/LOC) or pitch (G/S) mode on the primary FMA display indicating “mode fail”. The A/P will remain engaged until manually disengaged.

For ground station failures after annunciation of LAND 3 or LAND 2, the appropriate localizer or glideslope deviation scale will turn amber and flash, the corresponding deviation pointer will blank, and a horizontal amber line will be drawn through the appropriate roll (VOR/LOC) or pitch (G/S) mode on the primary FMA display indicating “mode fail”. The A/P will remain engaged until manually disengaged.

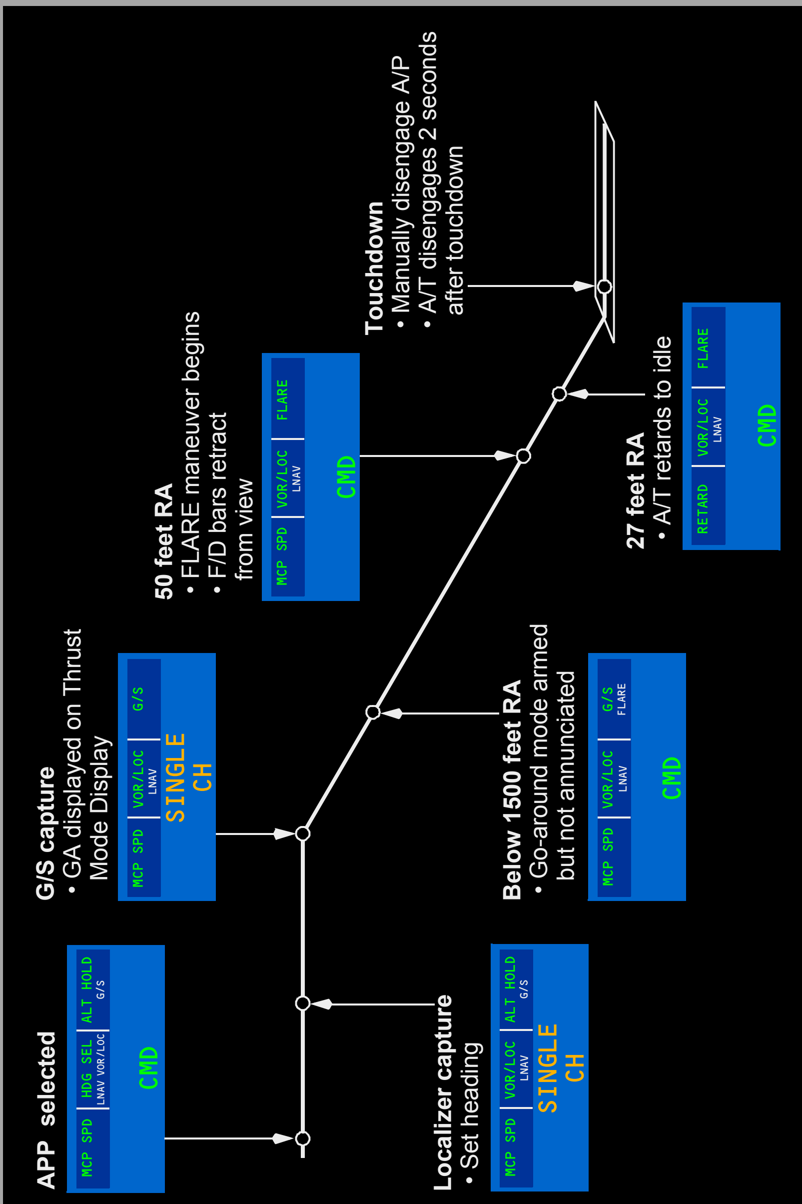
Single Engine Landing

If an engine fails and the APU is used to provide a second electrical source prior to engagement of the second autopilot, LAND 3 will be displayed (as installed), as the autopilot is still capable of providing rudder compensation throughout the approach and landing rollout. An approach and autoland to a decision height below 50 ft is prohibited.

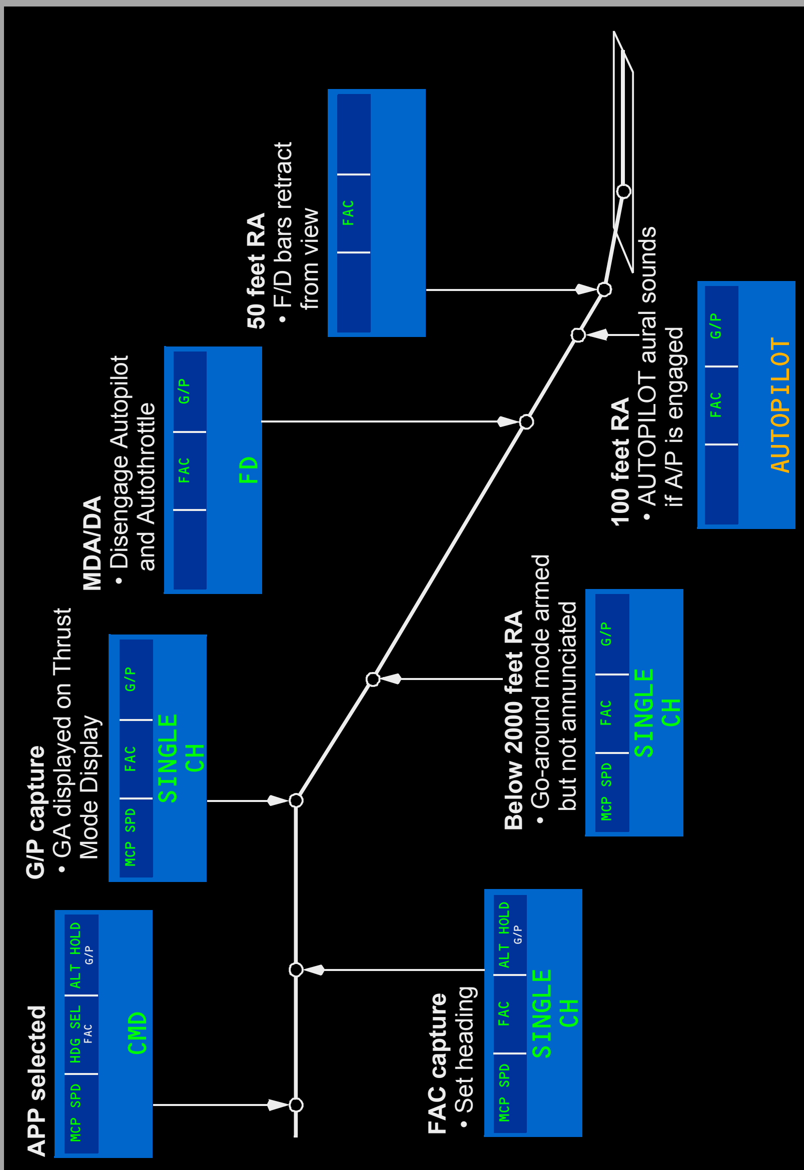
Automatic engine out rudder compensation is provided during A/P approach and landing.

In the event of a A/P go-around, the A/P will continue to compensate for asymmetric thrust until another roll mode is selected.

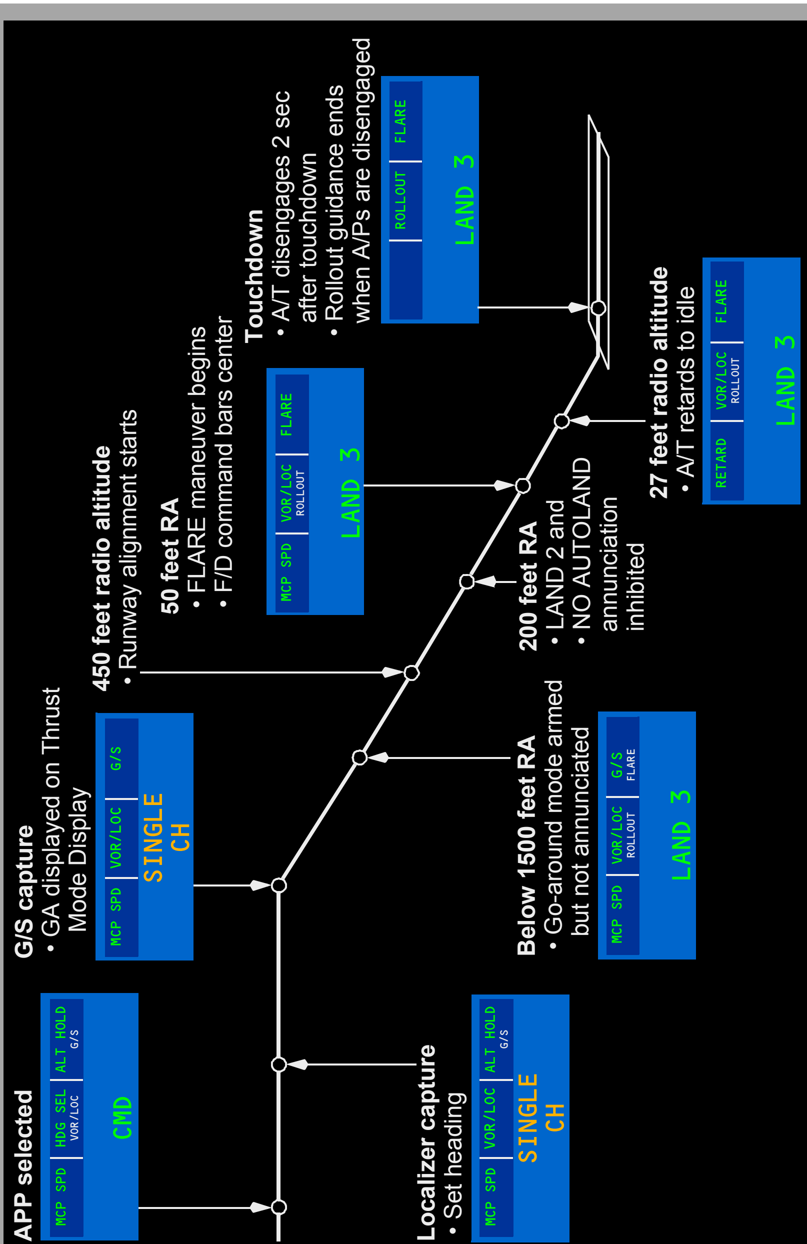
Automatic Flight Approach Profile



ILS APPROACH



IAN APPROACH



FAIL-OPERATIONAL APPROACH

Go–Around

Go–Around (GA) mode is engaged by pushing either TO/GA switch. An A/P go–around requires dual A/P operation and is armed when FLARE armed is annunciated. If both A/Ps are not operating, a manual F/D go–around is available.

With the A/T Arm switch at ARM, the A/T go–around mode is armed:

- when descending below 2000 feet RA
- when above 2000 feet RA with flaps not up or G/S captured
- with or without the AFDS engaged.

A/P Go–Around

The A/P GA mode requires dual A/P operation and is available after FLARE armed is annunciated and prior to the A/P sensing touchdown.

With the first push of either TO/GA switch:

- A/T (if armed) engages in GA and the A/T Engaged Mode annunciation on the FMA indicates GA
- thrust advances toward the reduced go–around N1 to produce 1000 to 2000 fpm rate of climb
- pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- F/D pitch commands 15 degrees nose up until reaching programmed rate of climb. F/D pitch then commands target airspeed for each flap setting based on maximum takeoff weight calculations
- F/D roll commands hold current ground track at or below 400 feet RA. Above 400 feet RA LNAV will engage. The Roll Mode annunciation will display LNAV armed at or below 400 feet RA and LNAV engaged above 400 feet RA.
- the IAS/Mach display blanks
- the command airspeed cursor automatically moves to a target airspeed for the existing flap position based on maximum takeoff weight calculations.

If the TO/GA switch is pressed after touchdown and prior to A/T disengagement, A/P disengages and the A/T may command GA thrust.

During a LAND 3, LAND 3 fail-operational (as installed), or LAND 2 fail-passive landing with LAND 3 or LAND 2 annunciated, pressing TO/GA switch after touchdown or activating the manual electric trim will be ignored by both autopilot channels, both flight directors, and the autothrottle system. This ensures that inadvertent press of the TO/GA switch does not affect rollout.

With the second push of either TO/GA switch after A/T reaches reduced go–around thrust, the A/T advances to the full go–around N1 limit.

TO/GA mode termination from A/P go–around:

- below 400 feet RA, the AFDS remains in the go–around mode unless both A/Ps and F/Ds are disengaged
- if the A/P is compensating for asymmetric thrust during the go-around, autopilot rudder control is disabled when a new pitch or roll mode is selected
- above 400 feet RA, select a different pitch or roll mode.
  - if the roll mode is changed first:
    - the selected mode engages in single A/P roll operation and is controlled by the A/P which was first in CMD
    - pitch remains in dual A/P control in TO/GA mode.
  - if the pitch mode is changed first:
    - the selected mode engages in single A/P pitch operation and is controlled by the A/P which was first in CMD
    - the second A/P disengages
    - the roll mode engages in CWS R.
  - the A/T GA mode is terminated when:
    - another pitch mode is selected
    - ALT ACQ annunciates engaged.

Note: The pitch mode cannot be changed from TO/GA until sufficient nose–down trim has been input to allow single channel A/P operation. This nose–down trim is automatically added by the A/P to reset the trim input made by the A/P at 400 feet RA and at 50 feet RA during the approach.

With pitch mode engaged in TO/GA, ALT ACQ engages when approaching the selected altitude and ALT HOLD engages at the selected altitude if the stabilizer position is satisfactory for single A/P operation.

- if stabilizer trim position is not satisfactory for single A/P operation:
  - ALT ACQ is inhibited
  - A/P disengage lights illuminate steady red
  - pitch remains in TO/GA.

Note: To extinguish A/P disengage lights, disengage A/Ps or select higher altitude on MCP.

F/D Go–Around

If both A/Ps are not engaged, a manual F/D only go–around is available under the following conditions:

- inflight below 2000 feet RA
- inflight above 2000 feet RA with flaps not up or G/S captured

- not in takeoff mode
- if the TO/GA switches are activated after touchdown (wheel spin-up).

With the first push of either TO/GA switch:

- A/T (if armed) engages in GA and advances thrust toward the reduced go–around N1 to produce 1000 to 2000 fpm rate of climb. The A/T Engaged Mode annunciation on the FMA indicates GA
- autopilot (if engaged) disengages
- pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- F/D pitch commands 15 degrees nose up until reaching programmed rate of climb. F/D pitch then commands target airspeed for each flap setting based on maximum takeoff weight calculations
- F/D roll commands hold current ground track at or below 50 feet AGL. Above 50 feet AGL, LNAV will engage. The Roll Mode annunciation will display LNAV engaged above 50 feet AGL.
- the IAS/Mach display blanks
- the command airspeed cursor automatically moves to a target airspeed for the existing flap position based on maximum takeoff weight calculations.

With the second push of either TO/GA switch (if A/T engaged and after A/T reaches reduced go–around thrust):

- the A/T advances to the full go–around N1 limit.

TO/GA mode termination from F/D go–around:

- below 400 feet RA, both F/D switches must be turned off
- above 400 feet RA, select a different pitch or roll mode.
  - if the roll mode is changed first:
    - F/D roll engages in the selected mode
    - F/D pitch mode remains in TO/GA.
  - if the pitch mode is changed first:
    - F/D pitch engages in the selected mode
    - F/D roll mode automatically changes to HDG SEL.
  - the A/T GA mode (if engaged) is terminated when:
    - another pitch mode is selected
    - ALT ACQ annunciates engaged.

Single Engine F/D Go–Around

With a push of either TO/GA switch:

- F/D roll commands hold current ground track at or below 50 feet AGL. Above 50 feet AGL, LNAV will engage. The Roll Mode annunciation will display LNAV engaged above 50 feet AGL
- pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- the F/D target speed is displayed on IAS/Mach display
- the F/D target speed is displayed on the airspeed cursor
- F/D pitch commands 13 degrees nose up. As climb rate increases, F/D pitch commands maintain a target speed.
  - if engine failure occurs prior to go–around engagement, then F/D target speed is the selected MCP speed
  - if engine failure occurs after go–around engagement, then F/D target speed depends on whether ten seconds have elapsed since go–around engagement:
    - if prior to ten seconds, the MCP selected approach speed becomes target speed
    - if after ten seconds and the airspeed at engine failure is within five knots of the go–around engagement speed, the airspeed that existed at go–around engagement becomes target speed
    - if after ten seconds and the airspeed at engine failure is more than five knots above go–around engagement speed, then the current airspeed becomes target speed.

Note: The target speed is never less than V2 speed based on flap position unless in windshear conditions.

F/D commanded acceleration cannot occur until a higher speed is selected on the MCP IAS/Mach display.

Go-Around Roll Mode – LNAV in Lieu of Track Hold

When multiple arm modes such as LNAV and VOR/LOC are set, they will appear on the FMA side by side in white.

When a missed approach exists in the flight plan and the FCCs are capable of entering go-around, LNAV arm will be annunciated on the FMA. The roll go-around track hold mode will automatically transition to LNAV during a missed approach.

During autoland operations with FLARE arm or FLARE engage displayed, if TO/GA is pressed with LNAV arm annunciated on the FMA, then LNAV will engage when the airplane is above 400 feet. Below that altitude the roll mode will be track hold.

During an approach without FLARE arm or FLARE engage displayed, if TO/GA is pressed with LNAV arm annunciated on the FMA, the flight director LNAV mode will engage when the airplane is above 50 feet. Below that altitude the mode will be track hold.

Single channel autopilot minimum engage and use heights are not affected. This feature is recommended to support RNP RNAV operations for terminal procedures requiring definitive course guidance.

Go-Around Roll Mode – LNAV in Lieu of Track Hold

(for Fail-Operational fleet)

When multiple arm modes such as LNAV and ROLLOUT are set, they will appear on the FMA side by side in white.

When a missed approach exists in the flight plan and the FCCs are capable of entering go-around, LNAV arm will be annunciated on the FMA. The roll go-around track hold mode will automatically transition to LNAV during a missed approach.

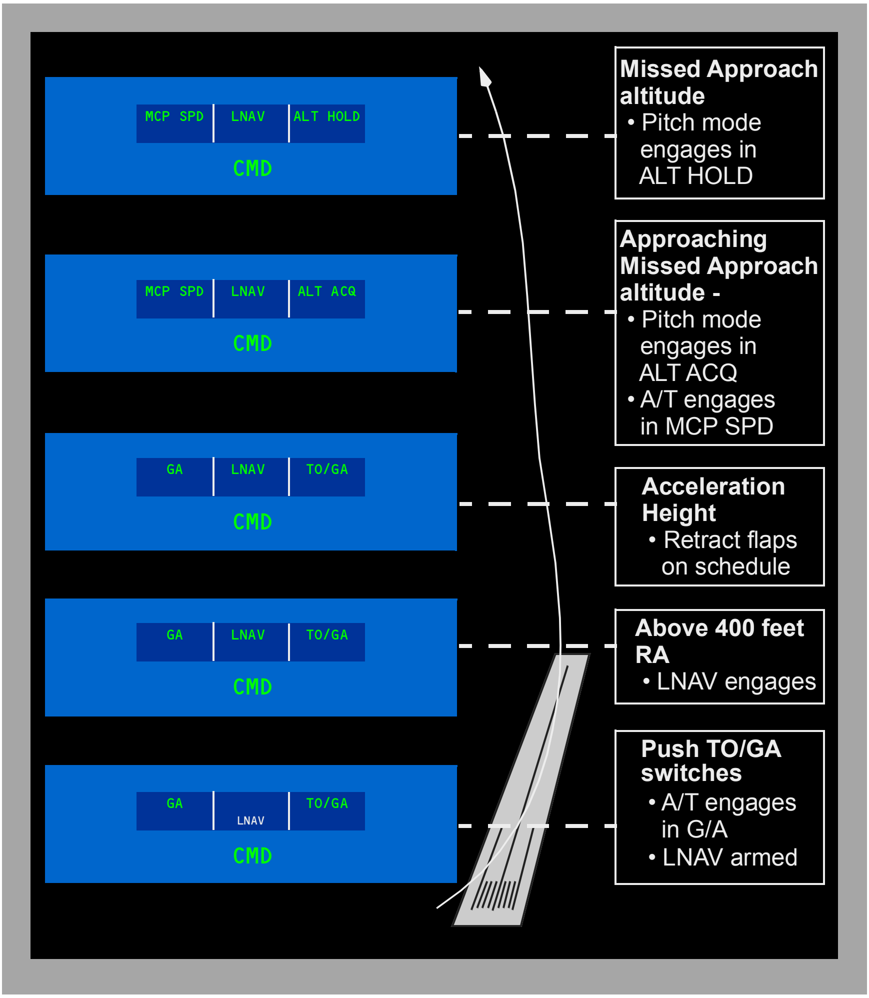
During autoland operations with LAND 2 / LAND 3 displayed and both engines operating, if TO/GA is pressed with LNAV arm annunciated on the FMA, then LNAV will engage when the airplane is above 400 feet. Below that altitude the roll mode will be track hold.

During an engine-out condition and both autopilot channels engaged, the LNAV arm annunciation will be removed from the FMA, if TO/GA is pressed the roll go-around mode will remain in track hold.

During an approach without LAND 2 or LAND 3 displayed, if TO/GA is pressed with LNAV arm annunciated on the FMA, the flight director LNAV mode will engage when the airplane is above 50 feet. Below that altitude the mode will be track hold.

Single channel autopilot minimum engage and use heights are not affected. This feature is recommended to support RNP RNAV operations for terminal procedures requiring definitive course guidance.

Automatic Flight Go–Around Profile



AFS Operation in Windshear

General

The autopilot and flight director provide positive corrective action to counteract most windshears. The autothrottle system also aids in windshear recovery by providing quick response to any increase or decrease in speed. The commanded levels of power may be beyond what the average pilot considers necessary but, in fact, are required by the situation.

Takeoff or Go–Around

If windshear is encountered during F/D takeoff or go–around, the F/D pitch command bar provides commands to maintain the target speed until vertical speed decreases to approximately +600 fpm. At this point, the F/D pitch bar commands a 15 degree nose–up pitch attitude. If vertical speed continues to decrease, the F/D continues to command a 15 degree pitch attitude until a speed of approximately stick shaker is reached. It then commands pitch attitudes which result in intermittent activation of the stick shaker. As the airplane transits the windshear condition, the F/D programming reverses. As climb rate increases above approximately +600 fpm, the F/D commands pitch attitudes which result in acceleration back to the target speed. The A/P and F/D both operate in a similar manner during A/P or F/D go–around.

Approach and Landing

If windshear is encountered during an ILS approach, both the F/D and A/P attempt to hold the airplane on altitude, or on glideslope after glideslope capture, without regard to angle of attack or stick shaker limitations. Airspeed could decrease below stick shaker and into a stall if the pilot does not intervene by pushing the TO/GA switch or disengaging the A/P and flying manually.

WARNING: Although the F/D, A/P and A/T may be performing as previously described, severe windshear may exceed the performance capability of the system and/or the airplane. In this situation, the flight crew must, if necessary to avoid ground contact, be prepared to disengage the autothrottle, advance thrust levers to the forward stop, disengage the autopilot and manually fly the airplane.

Command Speed Limiting and Reversion Modes

AFS command limiting and reversion operation is independent of the stall warning and mach warning systems.

Command Speed Limiting

The AFS provides speed, pitch and thrust commands to avoid exceeding the following limit speeds:

- Vmo/Mmo
- wing flap placards
- landing gear placard
- minimum speed.

The commanded speed can be equal to, but does not exceed a limit speed.

Speeds greater than Vmo/Mmo cannot be selected from the MCP. Speeds can be selected which exceed flap and gear placards or are less than minimum speed.

Minimum speed is based on angle of attack and is approximately 1.3 Vs for the current flap configuration. It is sensed by the angle of attack vanes, one on either side of the forward fuselage.

If a speed greater than a placard speed, or less than minimum speed is selected, the AFS allows acceleration or deceleration to slightly short of the limit, then commands the limit speed. The overspeed or underspeed limiting symbol appears in the MCP IAS/Mach display when the commanded speed cannot be reached.

Either pitch or thrust, whichever is engaged in a speed mode, attempts to hold the limit speed. The commanded limit speed and MCP speed condition symbol, remain until another speed is selected which does not exceed the limit. A speed 15 knots greater than the minimum speed must be selected to remove the underspeed limiting symbol.

Reversion Modes

During some flight situations, speed control by the AFDS or A/T alone could be insufficient to prevent exceeding a limit speed. If this occurs, AFDS or A/T modes automatically revert to a more effective combination. The reversion modes are:

- placard limit reversion
- minimum airspeed reversion.

Mode reversion occurs slightly before reaching the limit speed. Both the AFDS and A/T have reversion modes which activate according to the condition causing the reversion.

Placard Limit Reversion

When one of the placard limit reversions (gear, flap or Vmo/Mmo) is reached, the overspeed limiting symbol appears in the MCP IAS/Mach display and the following occurs:

- if the AFDS is engaged but not in speed or CWS mode, and the A/T is armed but not in speed control, the A/T reverts to SPEED and controls speed to slightly below the placard limit
- if the AFDS or A/T is in speed control, speed is maintained slightly below the placard limit
- for VMO/MMO only, if the A/T is engaged in a speed mode and the thrust levers are at idle, the AFDS, if in a V/S mode or CWS P, will automatically engage to LVL CHG mode
- if the A/T is not available, no reversion response to gear or flap placard speeds is available. The AFDS reverts to speed control for Vmo/Mmo speed limiting.

Minimum Speed Reversion

The AFDS and A/T do not control to a speed which is less than minimum speed for the current flap configuration. This speed is approximately 1.3 Vs. Minimum speed, FMC speed, or selected speed, whichever is higher, becomes the AFS commanded speed. If actual speed becomes equal to or slightly less than the minimum speed, the underspeed limiting symbol appears in the MCP IAS/MACH display, and if operating in the V/S mode or CWS P, the AFDS reverts to LVL CHG. The AFDS will also revert to LVL CHG from VNAV PTH, except when flying a level segment.

The AFS commands a speed 5 knots greater than minimum speed. Reaching a speed 5 knots greater than minimum speed reactivates normal MCP speed selection control. The AFDS commands nose down pitch to increase airspeed if the thrust levers are not advanced. When actual speed becomes 5 knots greater than minimum speed, the underspeed limiting symbol disappears.

The A/P disengages and the F/D command bars retract when in a LVL CHG climb with a command speed equal to minimum speed and a minimum rate of climb cannot be maintained without decelerating.

There is no minimum speed reversion from the following modes:

- ALT HOLD
- VNAV ALT (as installed)
- VNAV PTH (in a level segment)
- VNAV PTH (not in a level segment and flaps 15 or greater)
- V/S (flaps 15 or greater)
- G/P (as installed)
- G/S.

In the above modes with the autopilot engaged, the autopilot disengages and the F/D command bars (both pitch and roll) are removed one second after stick shaker activation. When airspeed increases to the top of the minimum maneuver speed (amber) bar, the F/D command bars (both pitch and roll) return and the autopilot can be re-engaged. If the previous F/D pitch commands were ALT HOLD, VNAV ALT (as installed) or VNAV PTH (in a level segment), the F/D pitch commands return in MCP SPD mode. Both the Indicated Airspeed (IAS) display and the speed bug will reference the existing airspeed when the F/D command bars return into view. If the previous F/D pitch commands were V/S (flaps 15 or greater), VNAV PTH (flaps 15 or greater), G/S or G/P (as installed), the F/D pitch commands return in the previous V/S, VNAV PTH, G/S or G/P (as installed) mode, respectively. For all cases the roll command returns in the previous mode.

Note: It is possible that stick shaker does not occur simultaneously on both the Captain and First Officer side due to AOA vane angle tolerances. In the event that stick shaker does not occur simultaneously, F/D command bars are removed one second after stick shaker activates on that side.

Communications — Chapter 5
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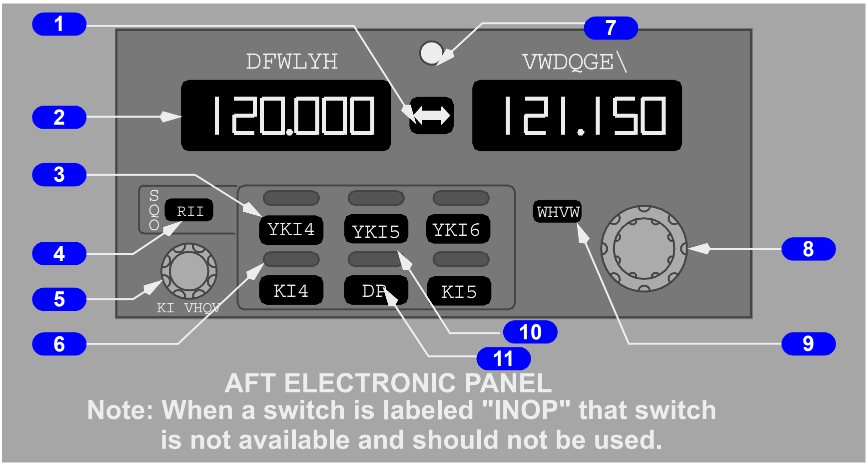
Radio Tuning Panel



1 Frequency Transfer Switch

Push –

- transfers the STANDBY window frequency to the ACTIVE window and tunes the selected radio to the new active frequency
- transfers the ACTIVE window frequency to the STANDBY window.

2 Frequency Indicator

ACTIVE – displays the tuned frequency of the selected radio.

STANDBY – displays the preselected or previously tuned frequency of the selected radio

- displays DATA if the selected radio is in the data mode.
- displays six digit frequency in 8.33 KHz spacing.

Note: Illustration Typical

3 Radio Tuning Switch

Push –

- selects the VHF or HF radio to be tuned
- the tuned frequency is displayed in the ACTIVE frequency indicator
- the standby frequency is displayed in the STANDBY frequency indicator

4 Radio Tuning Panel OFF Switch

Push –

- disconnects the panel from the communication radios
- switch illuminates (white).

5 HF Sensitivity Control

Rotate – adjusts the sensitivity of the on–side HF receiver.

6 Radio Tuning Light

Illuminated (white) - indicates the selected radio.

7 Offside Tuning Light

Illuminated (white) –

- the radio normally associated with this panel is being tuned by another radio tuning panel, or
- the radio tuning panel is being used to tune a radio not normally associated with this radio tuning panel.

8 Frequency Selector

Rotate - selects frequency in the STANDBY frequency indicator:

- first digit is always 1
- outer selector changes second and third digits in 1 MHz increments
- inner selector changes fourth, fifth, and sixth digits in 8.33 KHz increments.
- For airplanes with ACARS, tuning above maximum or below minimum frequency displays DATA in Frequency Indicator.

9 VHF TEST Switch

Push –

- removes automatic squelch feature, permitting reception of background noise and thereby testing receiver operation
- improves reception of weak signals.

10 AM Light

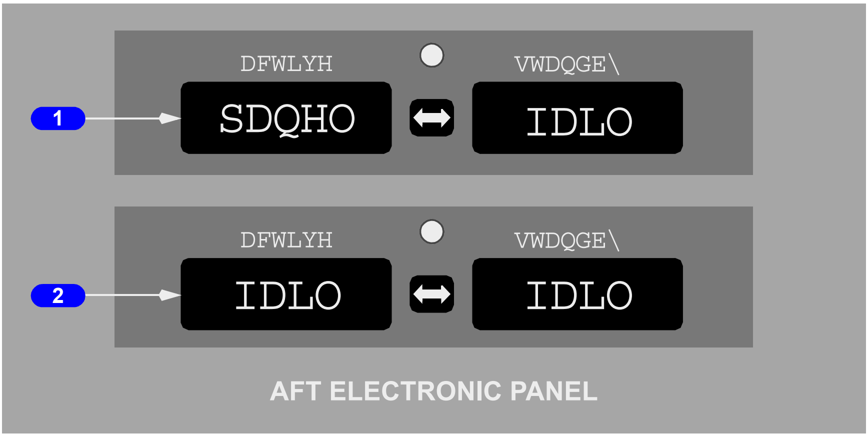
Illuminated (white) – HF AM is selected.

Extinguished – HF USB is selected.

11 AM Switch

Push – sets the AM (amplitude modulation) or USB (upper side band) mode for the selected HF.

Radio Tuning Panel Fail Modes



1 **PANEL FAIL**

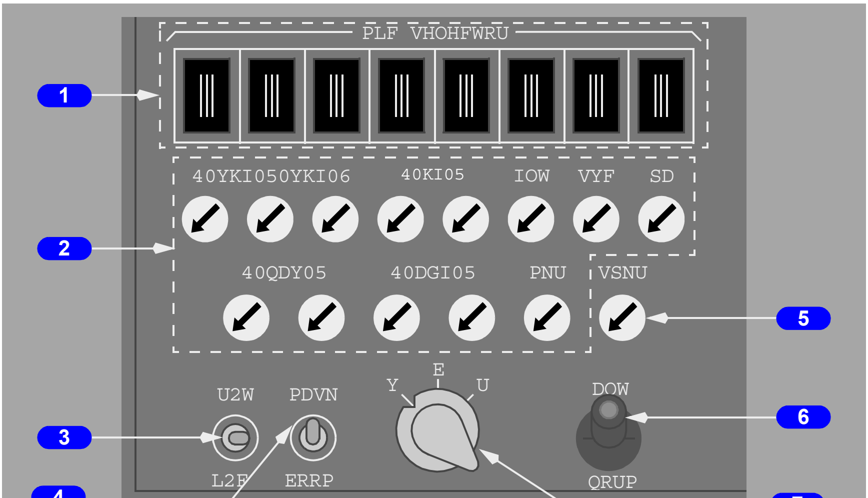
The radio tuning panel has failed.

2 **FAIL FAIL**

The selected radio has failed.

Note: The selected frequencies may continue to be displayed in the frequency indicator when the radio is not available.

Audio Control Panel (ACP)



FLIGHT DECK CREW STATIONS
Note: When a switch is labeled "INOP" that switch is not available and should not be used.

FLIGHT DECK CREW STATIONS
Note: When a switch is labeled "INOP" that switch is not available and should not be used.

1 Transmitter Selector (MIC SELECTOR) Switches

Illuminated – related switch is active

Push –

- selects related communication system for subsequent transmission
- only one switch may be selected at a time; pushing a second switch deselects first switch
- reception possible over selected system regardless of whether related receiver switch is on.

2 Receiver Switches

Illuminated (white) – related switch is active

Rotate – adjusts volume

Push –

- allows reception of related communication system or navigation receiver
- multiple switches may be selected

Push again – deselects related system or receiver.

3 Push–to–Talk Switch

(spring–loaded (R/T) / manually latch (I/C) to neutral position)

R/T (radio–transmit) – keys oxygen mask or boom microphone for transmission as selected by transmitter selector.

I/C (Intercom) – keys oxygen mask or boom microphone for direct transmission over flight interphone and bypasses transmitter selector.

3 Push–to–Talk Switch

(Radio-Interphone switch latched in the Interphone position)

RADIO (radio–transmit) – keys oxygen mask or boom microphone for transmission as selected by transmitter selector.

INT (Interphone) – keys oxygen mask or boom microphone for direct transmission over flight interphone and bypasses transmitter selector.

4 Filter Switch

V (Voice) – receive NAV and ADF voice audio.

B (Both) – receive NAV and ADF voice and range audio.

R (Range) – receive NAV and ADF station identifier range (code) audio.

4 MASK–BOOM Switch

MASK – selects oxygen mask microphone for transmissions.

BOOM – selects boom microphone for transmissions.

5 **Speaker (SPKR) Switch**

Illuminated (white) – SPKR switch is active.

Push – audio from selected receiver is heard on overhead speaker.

Rotate – adjusts overhead speaker volume.

Push again – deselects audio from selected receiver to be heard on overhead speaker.

5 **CALL Light**

Illuminated (white) – Accompanied by a chime, indicates call received by SELCAL, ACARS (if installed), ground crew (INT), SATCOM (if installed), or flight crew (CABIN).

Resets when transmitter is selected and microphone is keyed.

PA does not have a CALL indication.

6 **Alternate–Normal (ALT–NORM) Switch**

NORM (Normal) – ACP operates normally.

ALT (Alternate) – ACP operates in degraded mode.

6 **Speaker (SPKR) Switch**

Illuminated (white) – SPKR switch is active.

Push – audio from selected receiver is heard on overhead speaker.

Rotate – adjusts overhead speaker volume.

Push again – deselects audio from selected receiver to be heard on overhead speaker.

7 **Filter Switch**

V (Voice) – receive NAV and ADF voice audio.

B (Both) – receive NAV and ADF voice and range audio.

R (Range) – receive NAV and ADF station identifier range (code) audio.

7 **SAT Switch**

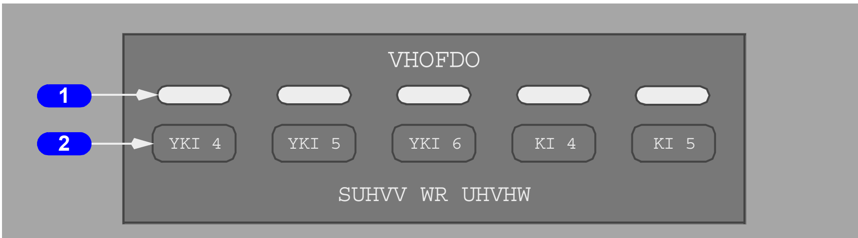
Push - Terminates the SATCOM call connection.

8 **Alternate-Normal (ALT-NORM) Switch**

NORM (Normal) – ACP operates normally.

ALT (Alternate) – ACP operates in degraded mode.

SELCAL Panel



AFT ELECTRONIC PANEL

Note: When a switch is labeled "INOP" that switch is not available and should not be used.

1 SELCAL Light

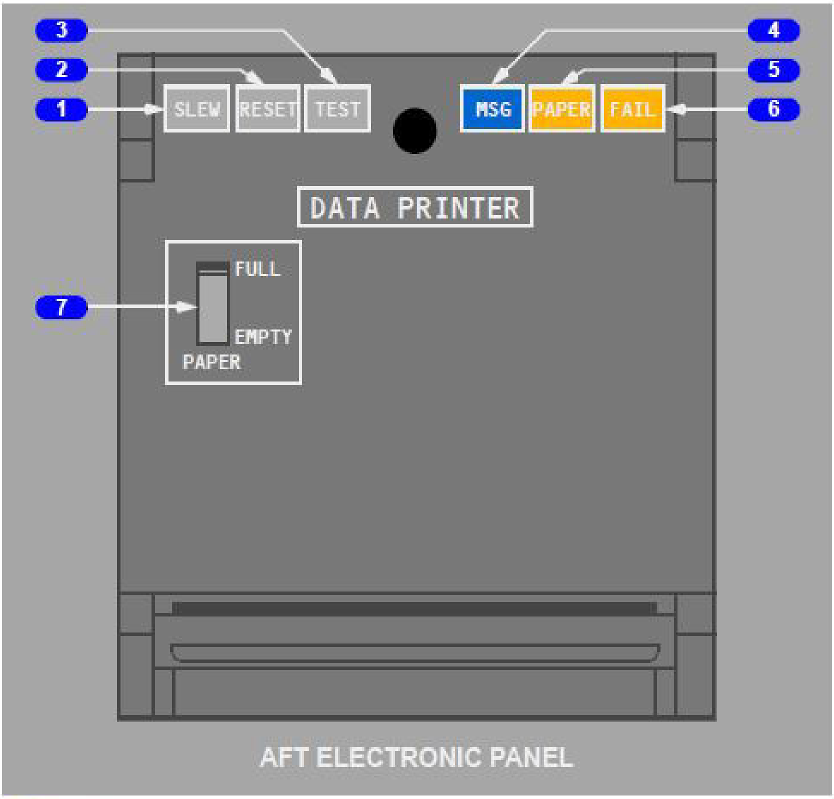
Illuminated (white) - alerts crew to incoming communication on indicated radio.

2 Reset Switch

Push - extinguishes and resets SELCAL light.

ACARS Printer

The Printer Control Panel lights brightness is controlled by rotating the "PANEL" brightness switch on the Flood and Aft Electronics Lights Control Panel, see chapter 1.30, located on the AFT ELECTRONIC PANEL.



1 Slew Switch

Push - advances paper as long as switch is depressed.

2 Reset Switch

Push - resets message light.

3 Test Switch

Push -

- produces character test pattern
- illuminates MSG and FAIL lights.

4 **Message Light**

Illuminated (blue) -

- incoming message to printer or
- test in progress

5 **Paper Light**

Illuminated (amber) - paper quantity low.

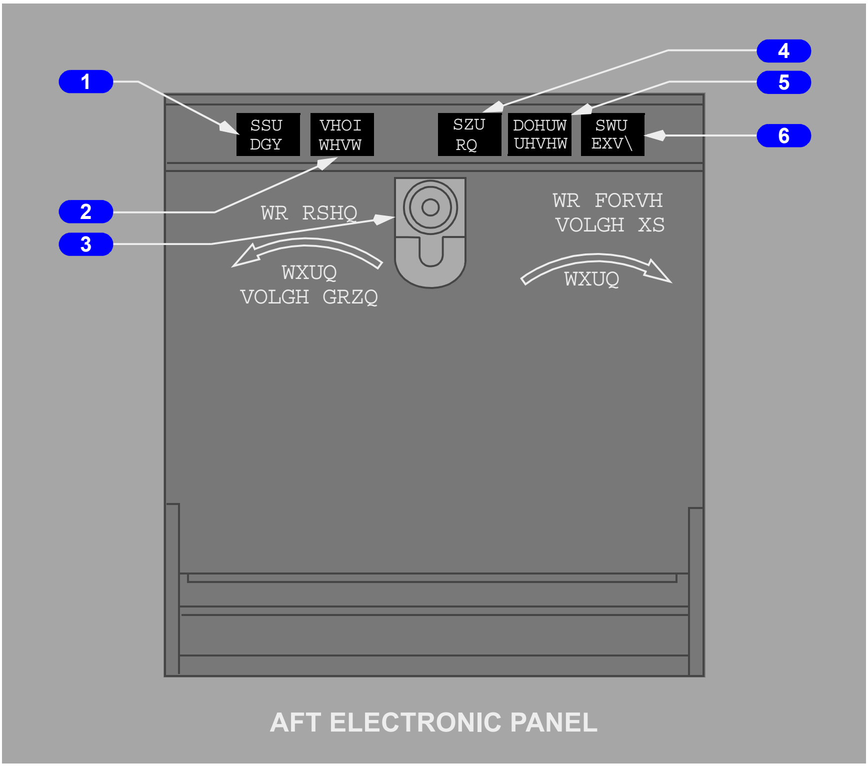
6 **Fail Light**

Illuminated (amber) - printer failure or test in progress.

7 **Paper Quantity Indicator**

Indicates amount of paper remaining.

The Printer Control Panel lights brightness is controlled by rotating the "PANEL" brightness switch on the Flood and Aft Electronics Lights Control Panel, see chapter 1.30, located on the AFT ELECTRONIC PANEL.



1 PAPER ADVANCE (PPR ADV) Switch

Push – advance paper while switch is held.

2 SELF-TEST Switch

Push - the printer will print a test pattern for as long as the switch is held.

3 Latch

Rotate and slide to open and close the printer cover.

4 Power On (PWR ON) Light

Illuminated when power is applied to the printer.

5 ALERT RESET Switch

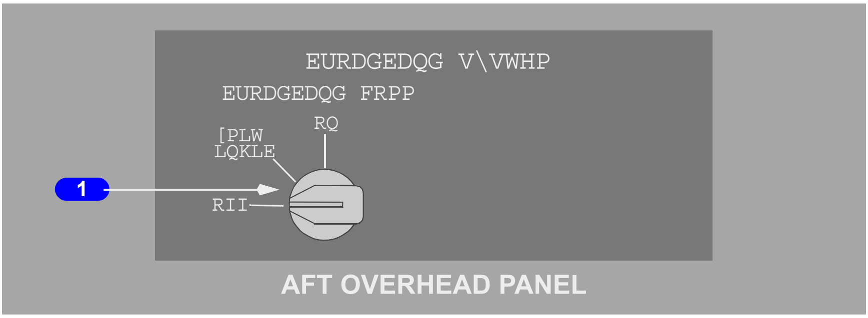
Turns off flashing PTR BUSY light.

6 Printer Busy (PTR BUSY) Light

Illuminated -

- printer is printing
- flashes when printing is complete.

Broadband System Switch



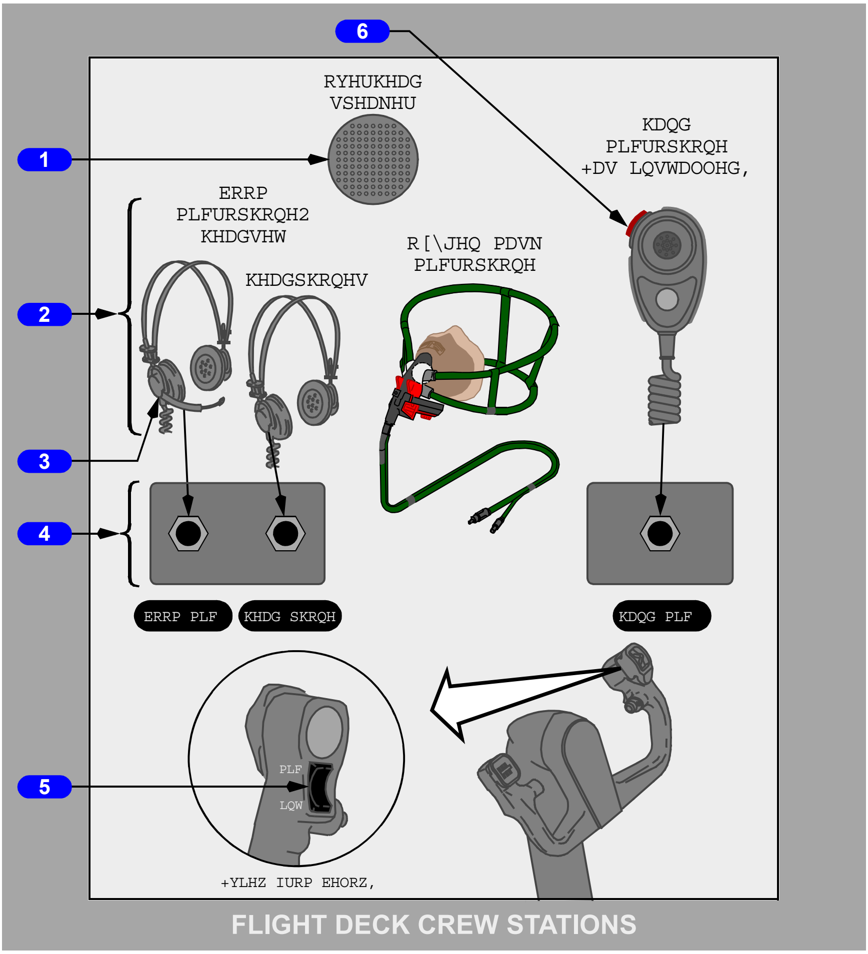
1 Broadband System Power/Mode Selector

OFF - removes power from the Broadband System.

XMIT INHIB- provides power to the Broadband System, but transmission is inhibited.

ON - provides power to the Broadband System. Allows gate-to-gate wireless network access to the crew and passengers.

Miscellaneous Communication Controls (Typical)



1 Overhead Speaker

Monitors audio from related pilot's ACP.

2 Headset or Headphones

Monitors audio from related ACP.

3 Standard Microphones

Choose desired microphone for voice transmission through selected radio, interphone system, or passenger address (PA).

4 Communication Jacks

Used for appropriate microphone or headphone plugs.

5 Push–To–Talk Switch

MIC (microphone) –

- selects oxygen mask or boom microphone for transmission, as selected by ACP transmitter selector.
- same as using ACP PTT switch (R/T position).

OFF – center position.

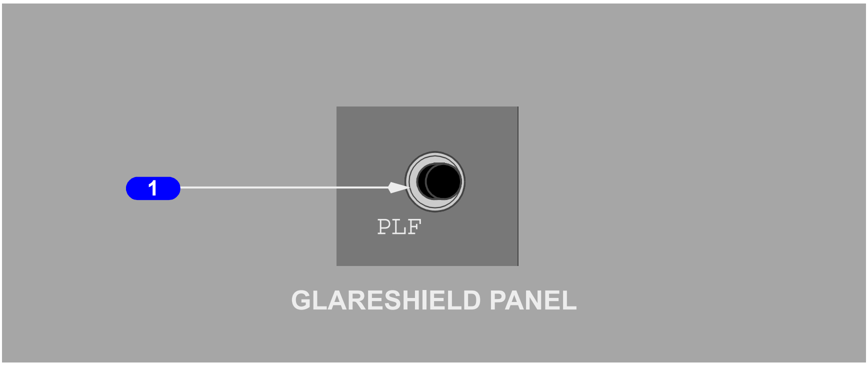
INT (interphone) –

- selects oxygen mask or boom microphone for direct transmission over flight interphone
- bypasses ACP transmitter selector
- same as using ACP PTT switch (I/C position)
- locks in INT position until selected to either OFF or MIC.

6 Push–To–Talk Switch

Push – keys hand microphone for transmission, as selected by ACP transmitter selector.

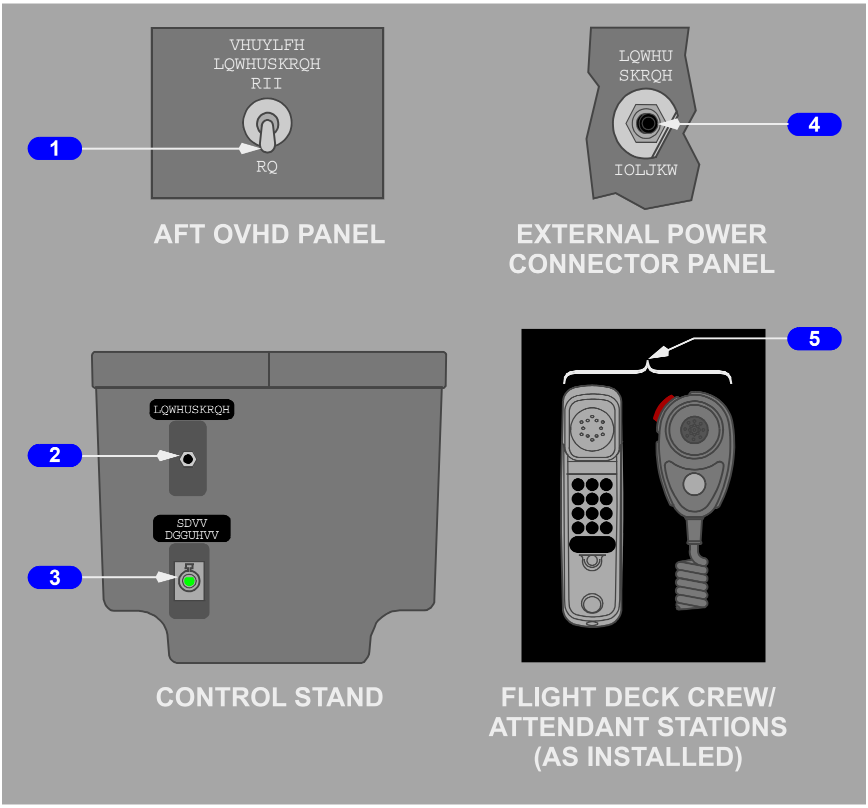
Glareshield Microphone Switch



1 Glareshield MIC Switch

Push - allows oxygen mask or boom microphone transmission on the selected transmitter.

Interphone and Passenger Address Controls



1 SERVICE INTERPHONE Switch

OFF –

- external jacks are deactivated
- communication between flight deck and flight attendants is still possible.

ON – adds external jacks to service interphone system.

2 Service INTERPHONE Handset Jack

With microphone installed, used to communicate with flight attendant stations:

- with SERVICE INTERPHONE switch ON, also used to communicate with any external jack location
- bypasses ACP.

3 **Passenger Address (PASS ADDRESS) Hand Microphone Jack**

With microphone installed:

- used to make PA announcements
- bypasses ACPs.

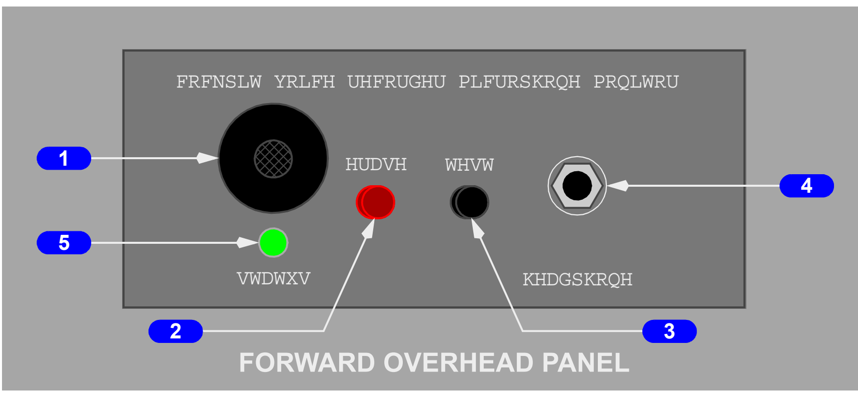
4 **INTERPHONE FLIGHT Jack**

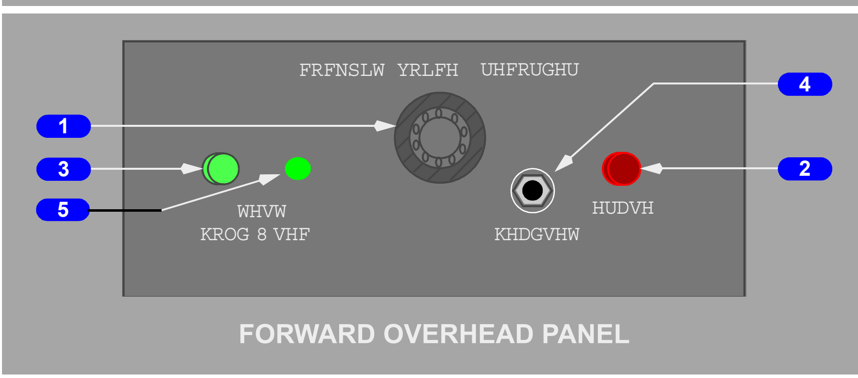
Connects ground crew to flight interphone system.

5 **Flight Deck / Attendant PA Hand Microphone**

Used to make PA announcements.

Cockpit Voice Recorder





1 **Area Microphone**

Active anytime 115V AC is applied to airplane or;

Activated when an engine is started or the VOICE RECORDER switch is placed in the ON position.

2 ERASE Switch (red)

Push (2 seconds) –

- all four channels are erased
- operative only when airplane is on ground and parking brake is set.

3 TEST Switch

Push – for 5 seconds:

- STATUS light flashes once
- a tone may be heard through a headset plugged into HEADPHONE jack.

3 TEST Switch (green)

Push –

- hold for 5 seconds.
- the TEST light illuminates.
- a tone may be heard through a headset plugged into the voice recorder headset jack.
- the TEST light remains illuminated until the switch is released.

4 HEADSET Jack

Headset may be plugged into jack to monitor tone transmission during test, or to monitor playback of voice audio.

4 HEADPHONE Jack

Headphone may be plugged into jack to monitor tone transmission during test, or to monitor playback of voice audio.

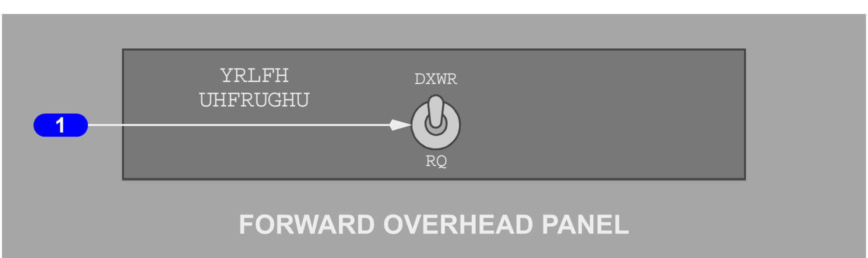
5 STATUS Light

Illuminated (momentary green) – no faults are detected during recorder TEST.

5 TEST Light

Illuminates (green) - when the TEST switch is depressed and either an engine is running or the Cockpit Voice Recorder Switch is in the ON position.

Cockpit Voice Recorder Switch

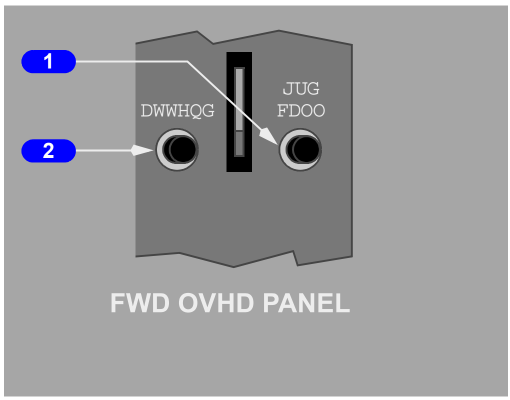


1 VOICE RECORDER Switch

AUTO - powers the cockpit voice recorder from first engine start until 5 minutes after last engine shutdown

ON - powers the cockpit voice recorder until first engine start, then trips the switch to AUTO.

Call System
Forward Overhead Panel



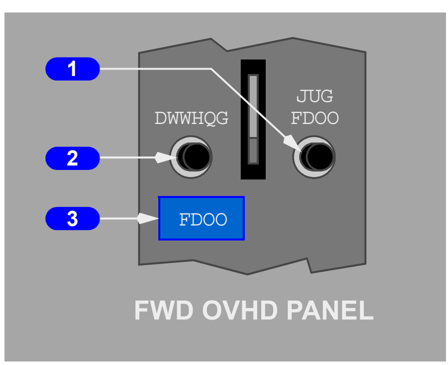
1 Ground Call (GRD CALL) Switch

Push – sounds a horn in nose wheel well until released.

2 Attendant Call (ATTEND) Switch

Push –

- sounds a two–tone chime in passenger cabin
- illuminates pink master call lights.



1 Ground Call (GRD CALL) Switch

Push – sounds a horn in nose wheel well until released.

2 Attendant Call (ATTEND) Switch

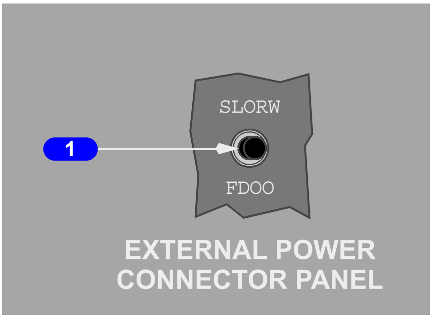
Push –

- sounds a two–tone chime in passenger cabin
- illuminates both pink master call lights.

3 Flight Deck CALL Light

Illuminated (blue) – flight deck is being called by flight attendants or ground crew.

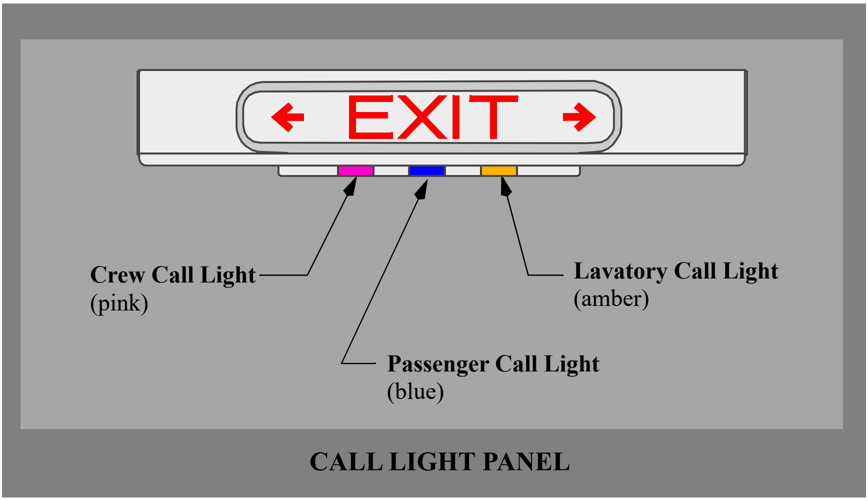
External Power Connector Panel



1 PILOT CALL Switch

Push – sounds a single–tone chime in flight deck.

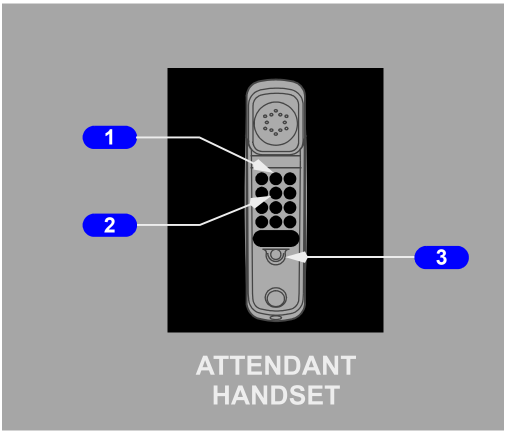
Master Call Lights



Call Light Illuminated –

- pink – flight deck or other flight attendant station is calling.
- blue – a passenger seat call switch is activated.
- amber – a lavatory call switch is activated.

Attendant Handset



1 CAPTAIN Call Switch

Push – sounds a single–tone chime in flight deck.

2 ATTENDANT Call Switch

Push –

- sounds a two–tone chime in passenger cabin
- illuminates both pink master call lights.

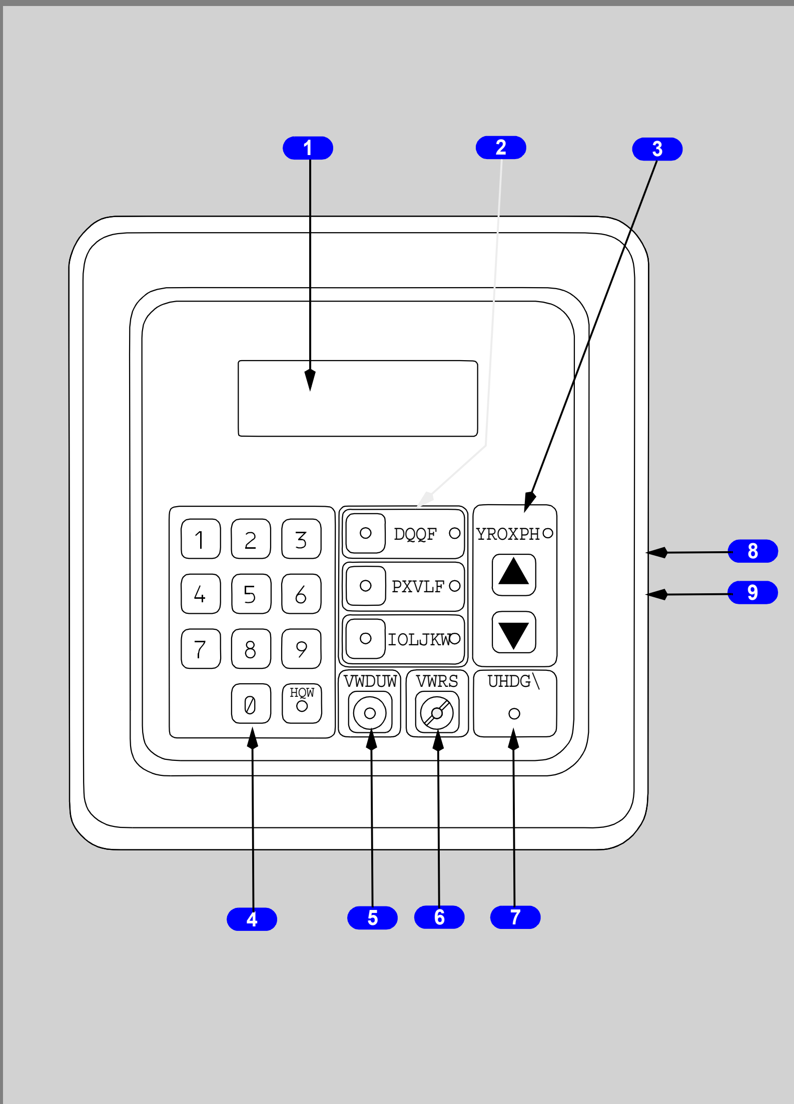
3 Call RESET Switch

Push –

- extinguishes both pink master call lights
- cancels call
- disconnects the handset from the public address system.

Pre-Recorded Announcement Machine (PRAM)

The PRAM is typically located above the FA seats on the LAV A wall.



PRE-RECORDED ANNOUNCEMENT MACHINE (PRAM)

1 **LCD Display**

Displays system status and announcement selection.

2 **Mode Control Select Switches**

Selectable Modes are:

- ANNC-manual announcement selection mode.
- MUSIC-music selection mode.
- FLIGHT-Flight pattern auto announcement selection mode.

3 **Music Volume**

Press ▲ (up button) to increase volume or ▼(down button) to decrease volume level.

4 **KEYPAD**

The Keypad is used to select desired pre-recorded announcements or music.

5 **START Button**

Press the START button to start announcement and music playback.

6 **STOP Button**

Press the STOP button to stop or cancel the announcement or music playback.

7 **READY Indicator**

Illuminates when Flight Pattern Block playback is ready to be started.

8 **Flash Card Memory Slot**

Location of the flash card memory installation to allow download of message files, music files, control software and flight pattern data.

9 **Monitor Jack**

Allows a headphone to be connected to review music and messages.

Communications — Chapter 5
System Description — Section 20

Introduction

The communication system includes:

- radio communication system
- interphone communication system
- cockpit voice recorder system
- communication crew alerting system

The communication systems are controlled using the:

- audio control panels
- radio tuning panels

Audio Systems and Audio Control Panels

An ACP is installed at the Captain, First Officer, and Observer stations. Each panel controls an independent crew station audio system and allows the crewmember to select the desired radios, navigation aids, interphones, and PA systems for monitoring and transmission.

Transmitter selectors on each ACP select one radio or system for transmission by that crewmember. Any microphone at that crew station may then be keyed to transmit on the selected system.

Receiver switches select the systems to be monitored. Any combination of systems may be selected. Receiver switches also control the volume for the headset and speaker at the related crew stations. Audio from each ACP is monitored using a headset/headphones or the related pilot’s speaker.

Audio warnings for altitude alert, ground proximity warning, traffic collision avoidance advisories and radar predictive windshear alerts are also heard through the speakers and headsets at preset volumes. They cannot be controlled or turned off by the crew.

Speakers and Headsets

Each crew station has a headset or headphone jack. The Captain and First Officer have speakers on the ceiling above their seats. There is no speaker at the observer station. Headset volume is controlled by the receiver switches. Speaker volume is controlled by the receiver switches and also the speaker switch. The speakers always operate during ground proximity warnings, altitude alert warnings, traffic collision avoidance advisories and radar predictive windshear alerts.

The two flight compartment speakers are muted for the Captain's and First Officer's push-to-talk microphone operation. The speakers are not muted for oxygen mask microphone operation.

Microphones

Hand microphones and boom microphones may be plugged into the related jacks at the flight deck crew stations. Each oxygen mask also has an integral microphone.

The MASK-BOOM switch allows selection of the oxygen mask microphone or the boom microphone. The MASK–BOOM switch does not affect the operation of the hand microphone.

An oxygen mask microphone is enabled and the boom microphone is disabled when the left oxygen mask panel door is open. The oxygen mask microphone is disabled and the boom microphone is enabled when the left oxygen mask panel door is closed and the RESET/TEST Switch is pushed.

The R/T and I/C switch is spring loaded to the neutral position when pressed to R/T. When pressed in the I/C position it latches.

Each hand microphone has a PTT switch to key the selected audio system. The PTT switches on the control wheel or ACP are used to key the oxygen mask or boom microphone, as selected by the RADIO/INT switch. The RADIO/INT switch does not affect the operation of the hand microphone.

A MIC switch mounted on the captain's and first officer's glareshield panel is used to key the oxygen mask or boom microphone, as selected by the transmitter switch on that pilot's ACP. Pushing the glareshield MIC switch is the same as pushing the control wheel MIC switch.

Normal Audio System Operation

The Captain, First Officer, and Observer audio systems are located in a common remote electronics unit in the E/E compartment. They function independently and have separate circuit breakers. The audio systems are normally controlled by the related ACPs through digital or computerized control circuits.

Degraded Audio System Operation

If the remote electronics unit or ACP malfunctions, the ACP cannot control the remote electronics unit. Audio system operation can be switched to a degraded mode by placing the ALT–NORM switch to ALT. In this mode, the ACP at that station is inoperative and the crewmember can only communicate on one radio.

The ACP transmitter selectors are not functional. Any transmission from that station must be from the radio shown on the chart below. The transmitter selector for the usable radio illuminates when a station is operating in the degraded mode. The receiver switches are not functional, and only the usable radio is heard at a preset volume, through the headset. The speaker and speaker switch are not functional at that station. In addition, the flight interphone and service interphone cannot be used. The control wheel PTT switch INT position and the ACP PTT switch INT position are not functional since the flight interphone is not functional.

The mask and boom microphones can be used for transmission on the usable radio. The mask and boom microphones can be keyed with the control wheel PTT switch in the MIC position or the ACP PTT switch in the RADIO position. The hand microphone is not usable in the degraded mode of operation.

Audio warnings for altitude alert, GPWS, and windshear are not heard on an audio system operating in the degraded mode.

An audio system operating in the degraded mode cannot access the passenger address system through the audio control panel. The crewmember can still use the service interphone handset and PA microphone if they are installed on the control stand.

CREW STATION AUDIO SYSTEM IN DEGRADED MODE	RADIO AVAILABLE FOR TRANSMISSION AND RECEPTION AT DEGRADED STATION
CAPTAIN	VHF–1
FIRST OFFICER	VHF–2
OBSERVER	VHF–1

Flight Interphone System

The flight interphone system is an independent communication network. Its primary purpose is to provide private communication between flight deck crewmembers without intrusion from the service interphone system. The ground crew may also use the flight interphone through a jack at the external power receptacle.

The pilots can transmit directly over the flight interphone by using the control wheel or glareshield PTT switches. Alternately, any crewmember with an ACP can transmit/receive over the flight interphone by using their related ACP and normal PTT switches. Any standard microphone may be used with the flight interphone system.

Service (Attendant) Interphone System

The service interphone system provides intercommunication between the flight deck, Flight Attendants, and ground personnel. Flight deck crewmembers communicate using either a separate handset (if installed) or their related ACP and any standard microphone.

The Flight Attendants communicate between flight attendant stations or with the flight deck using any of the attendant handsets. Anyone who picks up a handset/microphone is automatically connected to the system.

External jacks for use by maintenance or service personnel can be added to the system by use of the service interphone switch.

Passenger Address System

The Passenger Address (PA) system provides audio input to speakers in the cabin, allowing announcements and music to be broadcast to the entire passenger cabin. The speakers are installed in lavatories, the forward galley, near the aft entry/service doors and in the Passenger Service Units (PSUs). Input is prioritized by source.

The highest priority audio input source is selected when the flight crew selects "PA" on the audio control panel and speaks through the boom mic on a headset, the oxygen mask microphone or the hand-held microphone connected to the Passenger Address microphone jack on the P8 aft electronic panel. These methods will preempt all music and other announcements, including announcements in-progress by Flight Attendants in the cabin.

The second-priority level is announcements made using the Flight Attendant handsets. A Flight Attendant handset which is already being used to make an announcement has priority over any other Flight Attendant handset, the PRAM and entertainment systems.

The third-priority level is the PRAM. The PRAM provides pre-recorded messages and music over the PA system. Messages from the PRAM can be manually generated or automatically generated. Manually generated messages have priority over automatically generated messages, and both of these have priority over music being provided by the PRAM.

Pre-Recorded Announcement Machine (PRAM)

The PRAM uses pre-recorded announcements to automate the broadcasting of emergency and informational messages, as well as music, through the public address (PA) system in the cabin of the aircraft. When a passenger entertainment system is installed, announcements are also broadcast to each passenger through entertainment headsets.

The PRAM is typically located above the FA seats on the LAV A wall.

When an announcement is selected, the PRAM micro-processor accesses the announcement and broadcasts the information. PRAM announcements can be selected using the PRAM key pad after pressing the ANNC button on the Mode Control Select Panel. An announcement is automatically initiated whenever the "fasten seat belt" light is illuminated or cabin de-pressurization causes the cabin oxygen masks to drop. A flight pattern selection provides announcements that are programmed in blocks for a flight pattern or route. A flight pattern can have a maximum of 10 announcement blocks, with a maximum of 9 announcements per block

The PRAM content is developed by an operator based on operator-unique requirements such as required languages, message length, and the number of times the annoucements repeat. Typical announcements are:

- Emergency messages designed to reduce crew workload during critical times and to ensure emergency information is announced accurately and succinctly.
- Informational messages which are repeated often (EX: Fasten Seat Belts) and those which are long and interfere with crew operations (EX: customs information).

When the PRAM is initially powered-up, the PRAM performs a self-test. When the self-test is completed, the LCD momentarily displays "SELF TEST OK", then defaults to a display which shows the Boarding Music channel, Announcement number and File information.

There are three Selectable Modes:

- ANNC-manual announcement selection mode. To play one or more manual announcements, press the ANNC button.The ANNC button illuminates and an announcement prompt appears on the LCD.
  - To play a single announcement, enter the three digit code for the desired announcement. The LCD displays the selected announcement number, the announcement title and prompts the operator for confirmation. If the entry is correct, press the ENT button. Press the START button to initiate announcement playback.
  - To play multiple announcements in a series, enter the first announcement number, following the steps for a single announcement, up to and including pressing the ENT button, but do not press the START button. Press ENT again to enter the next announcement number. Repeat this process to enter a maximum of 9 announcements. Each announcement is stored in memory in the order it was selected. After all desired announcements have been entered, press the START button to initiate announcement playback.

- MUSIC-music selection mode. To play music, press the MUSIC button. The MUSIC light illuminates and a music selection screen appears on the LCD, along with the corresponding codes. Enter the code for the desired music title, using the KEY pad. The LCD will display the title and a prompt for confirmation. If selection is correct, press the ENT button, then press the START button.
- FLIGHT-Flight pattern auto announcement selection mode. Pressing the FLIGHT button illuminates the FLIGHT button and an input prompt appears on the LCD screen. Enter the desired flight pattern number and the LCD will display the flight pattern number and title, and prompt for confirmation. If the information is correct, press the ENT button. The LCD will display "Flight Mode Ready" and the READY light will illuminate. To initiate announcement playback, press the START button. The messages for BLOCK 1 will play. After a message block has completed, the subsequent message block will display. Initiate playback by pressing the START button.

Call System

The call system is used as a means for various crewmembers to gain the attention of other crewmembers and to indicate that interphone communication is desired. Attention is gained through the use of lights and aural signals (chimes or horn). The system can be activated from the flight deck, either flight attendant station, or from the external power receptacle. Passengers may also use the system to call an attendant, through the use of individual call switches at each seat.

The flight deck may be called from either flight attendant station or by the ground crew. The ground crew may only be called from the flight deck. Flight Attendants may be called from the flight deck, the other attendant station, or from any passenger seat or lavatory. Master call lights in the passenger cabin identify the source of incoming calls to the attendants.

Call system chime signals are audible in the passenger cabin through the PA system speakers. The PA speakers also provide an alerting chime signal whenever the NO SMOKING or FASTEN SEAT BELT signs illuminate or extinguish.

Location of Call Originator	Called Position	Visual Signal at Called Position	Aural Signal at Called Position
Flight deck	Attendant station	Pink master call light	Two–tone chime
Flight deck	Nose wheel well		Horn in nose wheel well
Attendant station	Flight deck	Call light on the integrated audio control panel	Single high–tone chime
External Power Connector Panel	Flight deck	Call light on the integrated audio control panel	Single high–tone chime
Flight deck	Passenger cabin	NO SMOKING or FASTEN BELT signs illuminate/ extinguish	Single low–tone chime

VHF Communications

Primary short–range voice communications is provided in the VHF range by three independent radios. Each radio provides for selection of an active frequency and an inactive (preselected) frequency. Voice transmission and reception are controlled at the related ACP.

The VHF/HF RTP-1 is located on the forward left side of the aft electronic panel, VHF/HF RTP–2 is on the forward right side and VHF/HF RTP–3 is on the aft portion of the panel. The VHF–2 and VHF-3 antennae are located on the lower fuselage, VHF–1 is on the upper fuselage.

Note: VHF antennae located on the lower fuselage are susceptible to multipath interference from nearby structures or vehicles. This may disrupt VHF communications. VHF antennae located on the upper fuselage are not as susceptible to this interference.

HF Communications

There are two independent HF communication radios, designated HF 1 and HF 2. Each HF radio can be tuned by any radio tuning panel. HF radio sensitivity can only be set on the on-side radio tuning panel.

The audio control panels are used to control voice transmission and receiver monitoring. When an HF transmitter is keyed after a frequency change, the antenna tunes. A steady or intermittent tone may be heard through the audio system. While tuning, the tone can last as long as 7 seconds. If the system fails to tune, the tone will last more than 7 seconds, to a maximum of 15 seconds. The antenna is located in the vertical stabilizer.

Note: Data for the last 100 tuned frequencies is stored in memory. Tuning duration for these stored frequencies will be very short and a tune tone may not be noticeable.

Both HF radios use a common antenna. When either HF radio is transmitting, the antenna is disconnected from the other HF radio, and it cannot be used to transmit or receive. However, both HF radios can receive simultaneously if neither is being used for transmitting.

Selective Calling (SELCAL)

A ground station desiring communications with the flight deck can use the SELCAL system. SELCAL monitors selected frequencies on VHF and HF radios. Each airplane is assigned a unique four–letter SELCAL code. When the system receives an incoming call from a ground station, a two–tone chime sounds and the respective SELCAL light illuminates.

Cockpit Voice Recorder

The cockpit voice recorder uses four independent channels to record flight deck audio for 120 minutes. Recordings older than 120 minutes are automatically erased. One channel records flight deck area conversations using the area microphone. The other channels record individual ACP output (headset) audio and transmissions for the pilots and observer.

The RIPS (Recorder Independent Power Supply) provides power to the cockpit voice recorder for 10 minutes after aircraft power is interrupted either by normal shutdown or by any other loss of power.

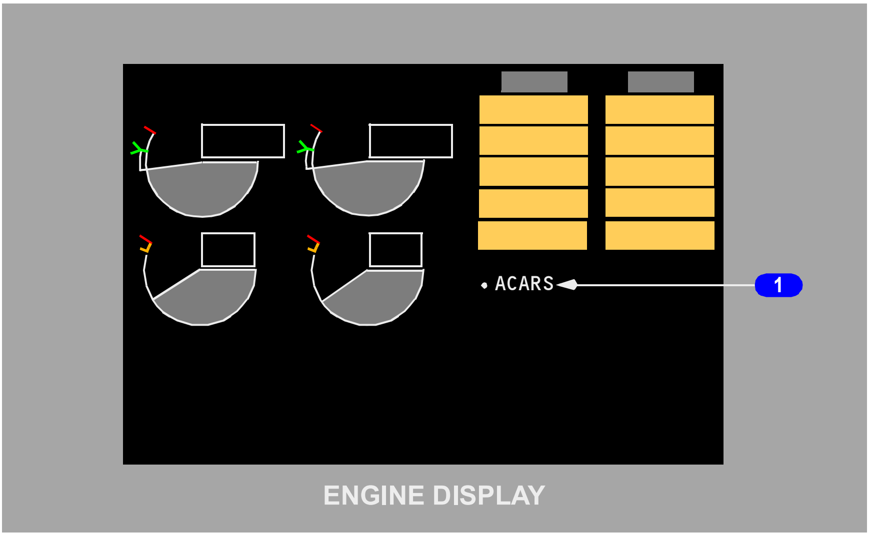
ACARS System

The ARINC Communications Addressing and Reporting System (ACARS) is an addressable digital data link system which permits exchange of data and messages between an airplane and a ground-based operation center utilizing an onboard VHF communications system.

The ACARS airborne subsystem provides for the manual entry of routine data such as departure/arrival information. Also possible is manual entry of addresses (telephone codes) of parties on the ground for voice communications.

The airborne system consists of a management unit in the E/E compartment, either an interactive display unit or multipurpose control display unit (MCDU), and frequently a printer. Data is entered and transmitted to the ground operations center.

ACARS Message



1 **•ACARS Uplink Message (white)**

Indicates receipt of an uplinked ACARS message. The uplink is identified by a CDU scratchpad message.

Satellite Communications (SATCOM) System

The SATCOM system provides both data and voice communications. The satellite data unit is controlled through the control display units (CDUs). Voice transmission is controlled using CDUs and the audio control panels.

Calls can be initiated using the CDU. Directories of airline defined numbers are line selectable or manual numbers can be entered. The SATCOM CDU control pages are displayed by selecting SAT on the MENU page.

SATCOM menu configuration is defined by the airline and is not presented here.

Broadband System

A dedicated broadband communications system provides passengers and crew with real-time, high-speed internet connectivity in flight. Passengers and crew access the system with compatible personal electronic devices (PEDs) using the cabin wireless access points (WAP).

The Broadband System is available from gate-to-gate.

Electrical — Chapter 6
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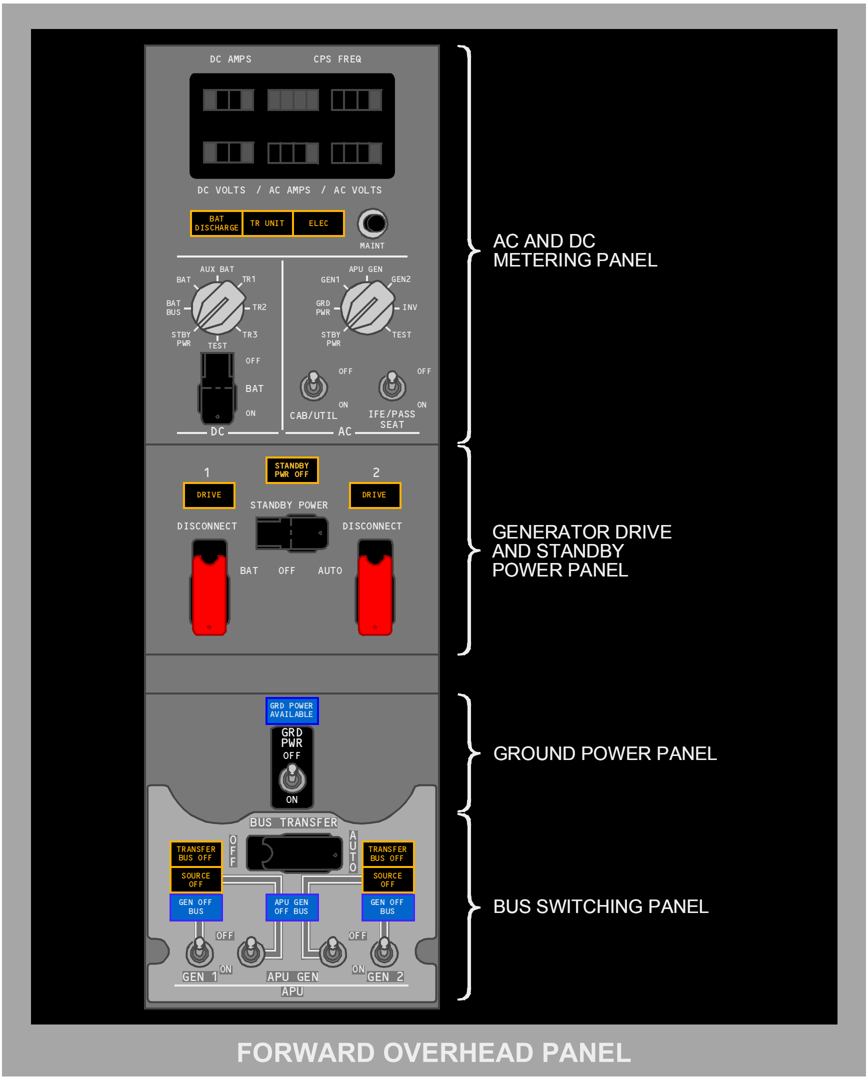
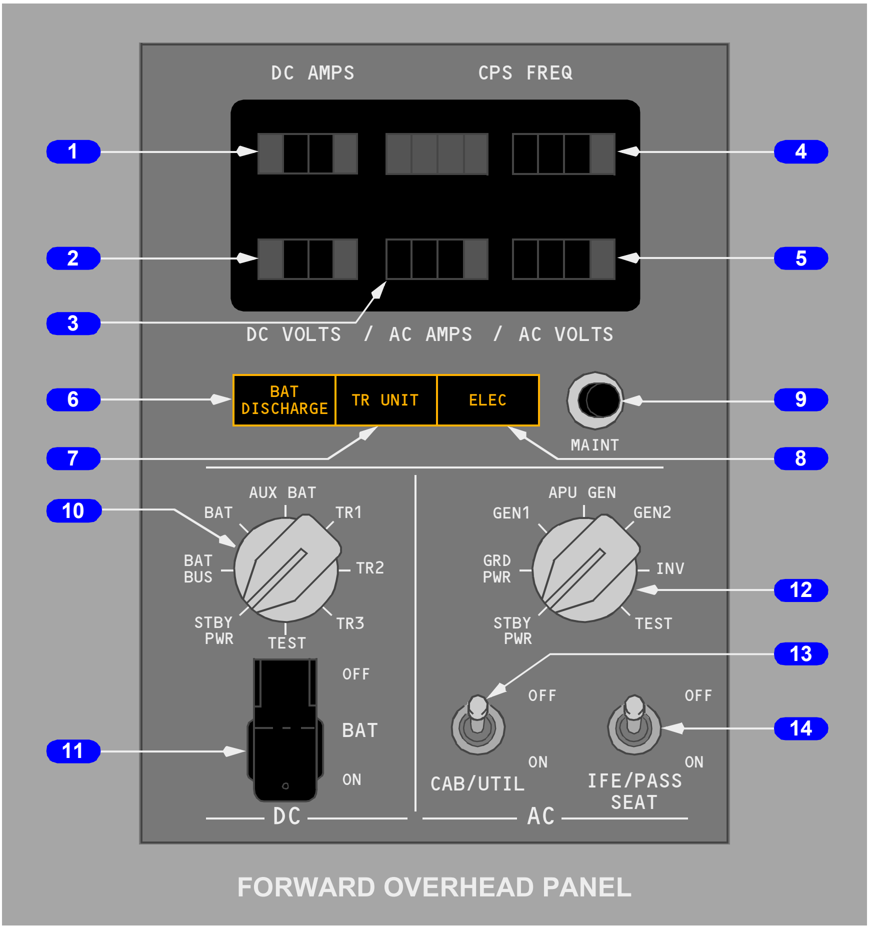
Electrical Panel



AC and DC Metering Panel



1 DC Ammeter

Indicates amperage of source selected by DC meters selector.

2 DC Voltmeter

Indicates voltage of source selected by DC meters selector.

3 AC Ammeter

Indicates amperage of source selected by AC meters selector.

4 Frequency Meter

Indicates frequency of source selected by AC meters selector.

5 AC Voltmeter

Indicates voltage of source selected by AC meters selector.

6 Battery Discharge (BAT DISCHARGE) Light

Illuminated (amber) – with BAT switch ON, excessive battery discharge detected.

7 TR UNIT Light

Illuminated (amber) –

- on the ground – any TR has failed.
- in flight –
  - TR1 failed; or
  - TR2 and TR3 failed.

8 Electrical (ELEC) Light

Illuminated (amber) – a fault exists in DC power system or standby power system.

Note: Operates only with airplane on ground.

9 Maintenance Test (MAINT) Switch

Used by maintenance.

10 DC Meters Selector

Selects DC source for DC voltmeter and DC ammeter indications.

TEST – used by maintenance.

11 Battery (BAT) Switch

OFF –

- removes power from battery bus and switched hot battery bus when operating with normal power sources available
- removes power from battery bus, switched hot battery bus, DC standby bus, static inverter, and AC standby bus when battery is only power source.

ON (guarded position) –

- provides power to switched hot battery bus
- energizes relays to provide automatic switching of standby electrical system to battery power with loss of normal power.

12 AC Meters Selector

Selects AC source for AC voltmeter, AC ammeter and frequency meter indications

TEST – used by maintenance.

13 CAB/UTIL Switch

OFF – removes electrical power from galley and cabin equipment systems including:

- all 115V AC galley buses
- fwd and aft door area heaters
- drain mast heaters
- lavatory water heaters
- logo lights
- potable water compressor
- 115V AC shaver outlets when installed
- LED cabin lighting

ON – supplies electrical power to galley and cabin equipment systems.

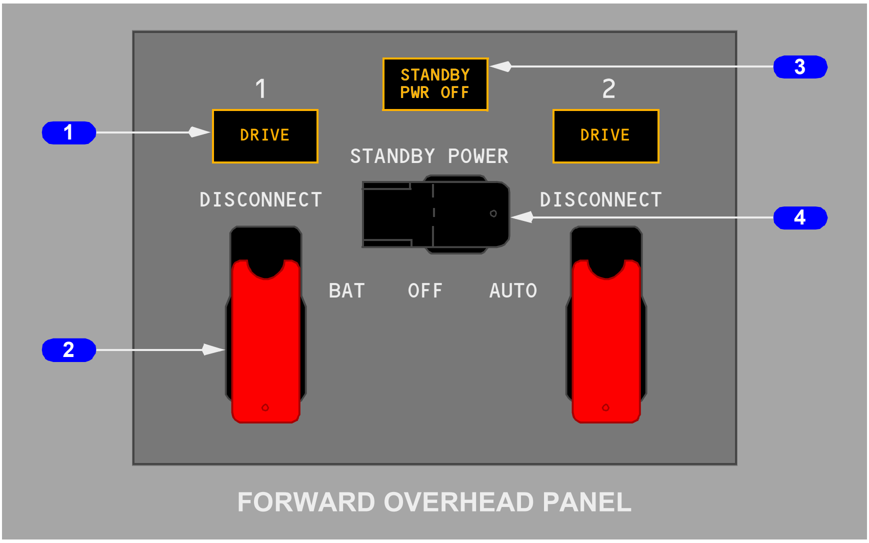
14 IFE/PASS SEAT Switch

OFF – removes electrical power from installed components of the passenger seats, in-flight entertainment systems, and other power systems including:

- 115V AC audio entertainment equipment
- 115V AC video entertainment equipment
- cabin telephone equipment
- FAX machine
- 28V DC video equipment and passenger seat electronic outlets
- 115V AC flight deck auxiliary power outlets

ON – supplies electrical power to installed components of the passenger seats, in-flight entertainment systems, and other power systems.

Generator Drive and Standby Power Panel



1 Generator Drive (DRIVE) Lights

Illuminated (amber) – Integrated drive generator (IDG) low oil pressure caused by one of the following:

- IDG failure
- engine shutdown
- IDG automatic disconnect due to high oil temperature
- IDG disconnected through generator drive DISCONNECT switch.

2 Generator Drive Disconnect (DISCONNECT) Switches (guarded)

Disconnects IDG if electrical power is available and engine start lever is in IDLE. IDG cannot be reconnected in the air.

3 STANDBY Power Off (PWR OFF) Light

Illuminated (amber) – one or more of the following buses are unpowered:

- AC standby bus
- DC standby bus
- battery bus.

4 STANDBY POWER Switch

AUTO (guarded position) –

- In flight, or on the ground, and AC transfer buses powered:
  - AC standby bus is powered by AC transfer bus 1
  - DC standby bus is powered by TR1, TR2 and TR3
- In flight, or on the ground, loss of all AC power
  - AC standby bus is powered by battery through static inverter
  - DC standby bus is powered by battery
  - Battery bus is powered by battery.

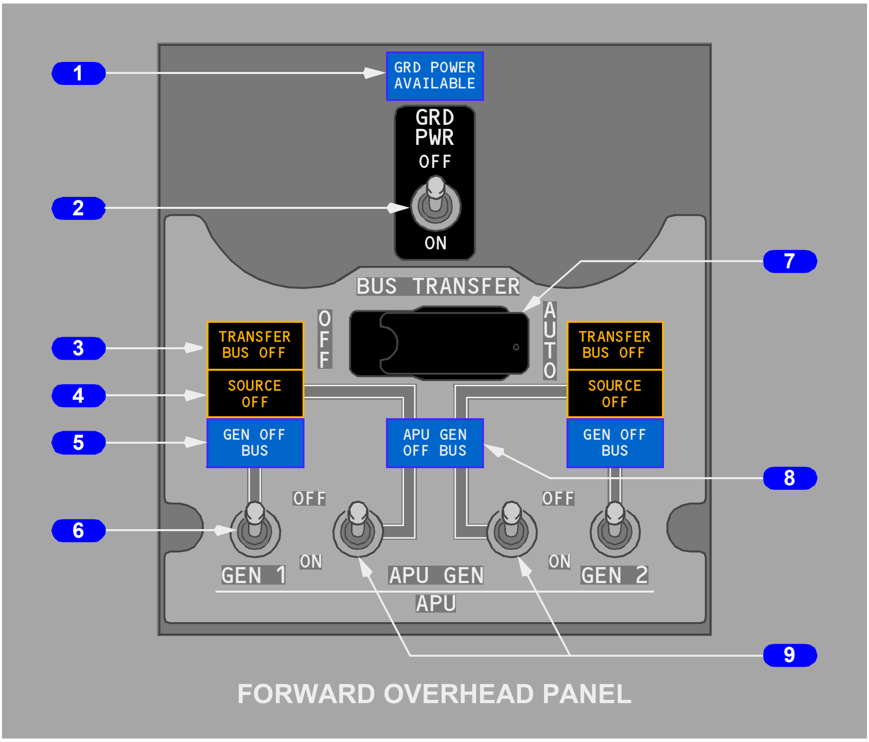
OFF (center position) –

- STANDBY PWR OFF light illuminates
- AC standby bus, static inverter, and DC standby bus are not powered.

BAT (unguarded position) –

- AC standby bus is powered by battery through static inverter
- DC standby bus and battery bus are powered directly by battery.

Ground Power Panel and Bus Switching Panel



1 Ground Power Available (GRD POWER AVAILABLE) Light

Illuminated (blue) – ground power is connected and meets airplane power quality standards.

2 Ground Power (GRD PWR) Switch

Three position switch, spring–loaded to neutral

OFF – disconnects ground power from AC transfer buses.

ON – if momentarily moved to ON position and ground power is available:

- removes previously connected power from AC transfer buses
- connects ground power to AC transfer buses if power quality is correct.

3 TRANSFER BUS OFF Lights

Illuminated (amber) – related transfer bus is not powered.

4 SOURCE OFF Lights

Illuminated (amber) – no source has been manually selected to power the related transfer bus, or the manually selected source has been disconnected

- if a source has been selected to power the opposite transfer bus, both transfer buses are powered.

5 Generator Off Bus (GEN OFF BUS) Lights

Illuminated (blue) – IDG is not supplying power to the related transfer bus.

6 Generator (GEN) Switches

Three position switch, spring–loaded to neutral.

OFF – disconnects IDG from related AC transfer bus by opening generator circuit breaker.

ON – connects IDG to related AC transfer bus by disconnecting previous power source and closing generator circuit breaker,

7 BUS TRANSFER Switch

AUTO (guarded position) – BTBs operate automatically to maintain power to AC transfer buses from any operating generator or external power

- DC cross tie relay automatically provides normal or isolated operation as required.

OFF – isolates AC transfer bus 1 from AC transfer bus 2 if one IDG is supplying power to both AC transfer buses

- DC cross tie relay opens to isolate DC bus 1 from DC bus 2.

8 APU Generator Off Bus (GEN OFF BUS) Light

Illuminated (blue) – APU is running and not powering a bus.

9 APU Generator (GEN) Switches

Three position switch, spring–loaded to neutral.

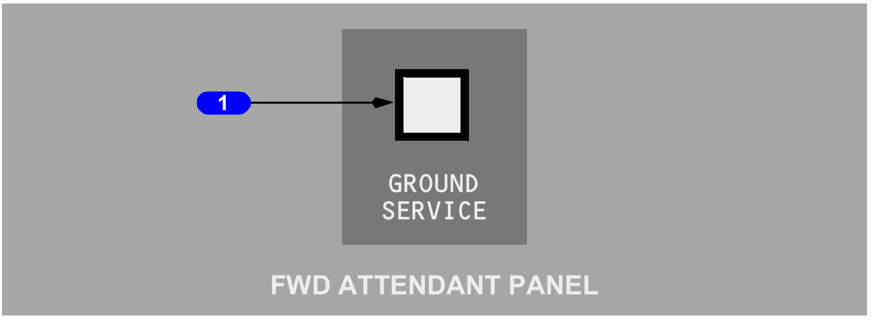
OFF –

- APU generator powering both AC transfer buses
  - moving a single APU GEN switch to OFF illuminates related SOURCE OFF light. APU continues to power AC transfer buses
  - subsequently moving other APU GEN switch to OFF disconnects APU generator from tie bus and removes APU power from AC transfer buses
- APU generator powering one AC transfer bus; IDG powering one AC transfer bus
  - moving related APU GEN switch to OFF disconnects APU generator from tie bus and AC transfer bus. IDG powers AC transfer buses.

ON –

- Neither AC transfer bus powered by IDG – moving a single APU GEN switch to ON:
  - connects both AC transfer buses to the APU generator
  - disconnects external power, if connected
  - opposite SOURCE OFF light illuminates until the other APU GEN switch is moved to ON.
- Both AC transfer buses powered by IDGs – moving an APU GEN switch ON:
  - powers the related AC transfer bus from the APU generator
  - other AC transfer bus continues to receive power from the IDG.

Ground Service Switch



1 GROUND SERVICE Switch

Momentary push–button switch.

Provides manual control of ground service buses. Enables servicing airplane using external power without activating AC transfer buses.

Illuminated (white) –

- ON – connects external power to ground service buses
- OFF – disconnects external power from ground service buses.

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Blank

Introduction
Dual Battery

Primary electrical power is provided by two engine integrated drive generators (IDGs) which supply three-phase, 115 volt, 400 cycle alternating current. Each IDG supplies its own bus system in normal operation and can also supply essential and non-essential loads of the opposite side bus system when one IDG is inoperative. Transformer rectifier (TR) units and the main battery/battery charger supply DC power. The main and auxiliary batteries also provide backup power for the AC and DC standby system. The APU operates a generator and can supply power to both AC transfer buses on the ground or in flight.

There are two basic principles of operation for the 737 electrical system:

- There is no paralleling of the AC sources of power.
- The source of power being connected to a transfer bus automatically disconnects an existing source.

The electrical power system may be categorized into three main divisions: the AC power system, the DC power system, and the standby power system.

Electrical Power Generation
Engine Generators

Primary power is obtained from two engine IDGs. The IDG maintains a constant generator speed throughout the normal operating range of the engine. An integral electro–mechanical disconnect device provides for complete mechanical isolation of the IDG.

APU Generator

The APU generator can supply power to both AC transfer buses on the ground or in flight. As the only power source, the APU generator can meet electrical power requirements for all ground conditions and most flight conditions.

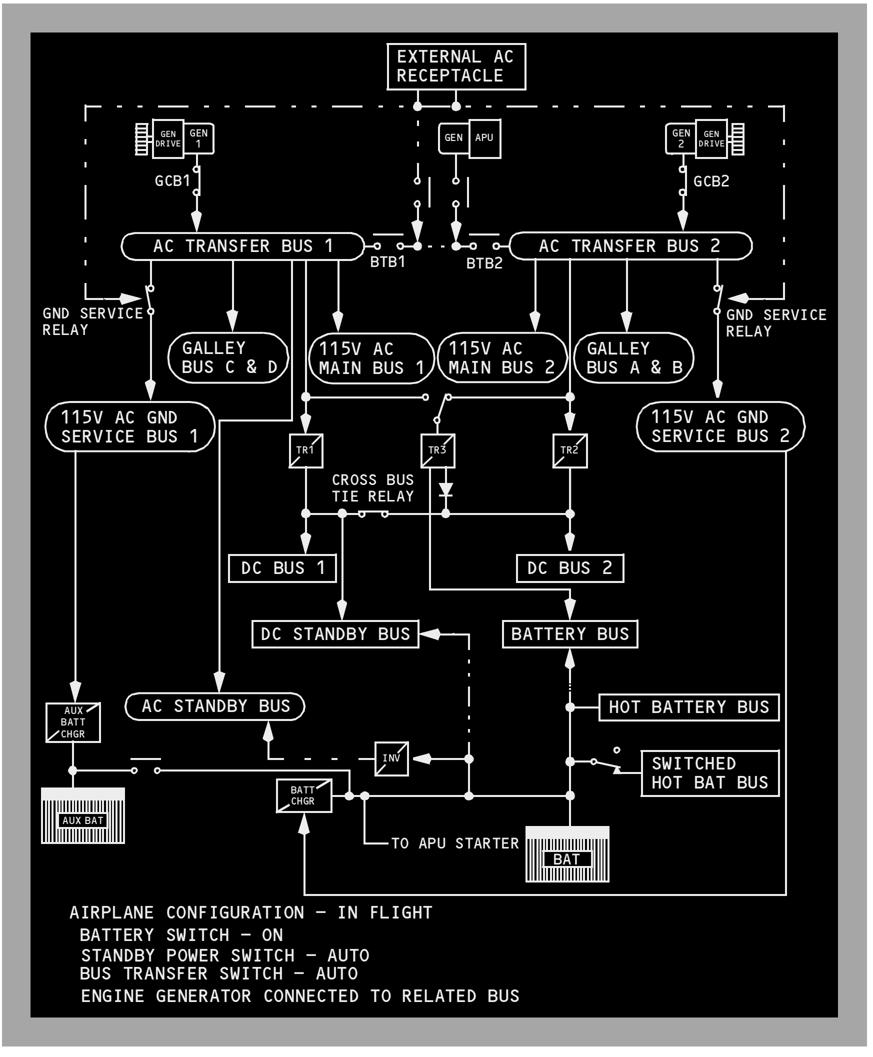
External Ground Power

An external AC power receptacle located near the nose gear wheel well, on the lower right side of the fuselage, allows the use of an external power source. Status lights on a panel adjacent to the receptacle permit the ground crew to determine if external power is being used. When connected, external power can supply power to both transfer buses.

Ground Service

For ground servicing, a ground service switch is on the forward attendant's panel. The switch provides ground power directly to the AC ground service buses for utility outlets, cabin lighting and the battery charger without powering all airplane electrical buses. The ground service switch is a momentary push button and is overridden when both AC transfer buses are powered.

Electrical Power Schematic



AC Power System

Each AC power system consists of a transfer bus, a main bus, two galley buses, and a ground service bus. Transfer bus 1 also supplies power to the AC standby bus. If the AC source powering either transfer bus fails or is disconnected, the transfer bus can be powered by any available source through the tie bus with the bus tie breakers (BTBs).

With the airplane on the ground and both generator control switches OFF, or with both engines shut down, selecting the GRD PWR switch ON connects external power to both transfer buses. Likewise, selecting either APU GEN switch ON connects APU power to both transfer buses. Whichever source is selected last powers both buses. It is not possible to power one transfer bus with external power and one transfer bus with APU power.

The transfer buses can be powered from the engine generators by momentarily positioning the related generator switch to ON. This closes the related generator circuit breaker (GCB) and connects the generator to the transfer bus. Whenever external power or APU is powering both transfer buses, and engine generator power is applied to its onside transfer bus, external power or APU continues to supply power to the remaining transfer bus.

In flight, each engine generator normally powers its own transfer bus. If an engine generator is no longer supplying power, the BTBs automatically close to allow the other engine generator to supply both transfer buses through the tie bus and BTBs. The APU can power either or both buses through the BTBs.

The system also incorporates an automatic generator on–line feature in case the airplane takes off with the APU powering both transfer buses. If the APU is either shut down or fails, the engine generators are automatically connected to their related transfer buses. This action occurs only once in flight and only under the circumstances described above.

Bus Tie System

Either generator or the APU can supply power to both transfer buses. If the BUS TRANS switch is in the AUTO position and the source powering the transfer bus is disconnected or fails, the source powering the opposite transfer bus automatically picks up the unpowered transfer bus through the BTBs.

Flight Deck Auxiliary Power System

The system is composed of a power converter and AC outlets on the P6 and P18 panels to provide power for Flight Deck Personal Electronic Devices (PEDs). A protective device is a part of the safety aspect of the outlets to prevent tampering with foreign objects. PEDs that are plugged into the Flight Deck Auxiliary Power outlets must be fully inserted into the outlet with the prongs of the plug inserted simultaneously to activate the protective device. If a plug is not inserted correctly, electrical power will not be present at the outlet and the plug will need to be removed and reinserted.

Note: Plugs installed before power up will need to be removed and reinserted to achieve electrical power.

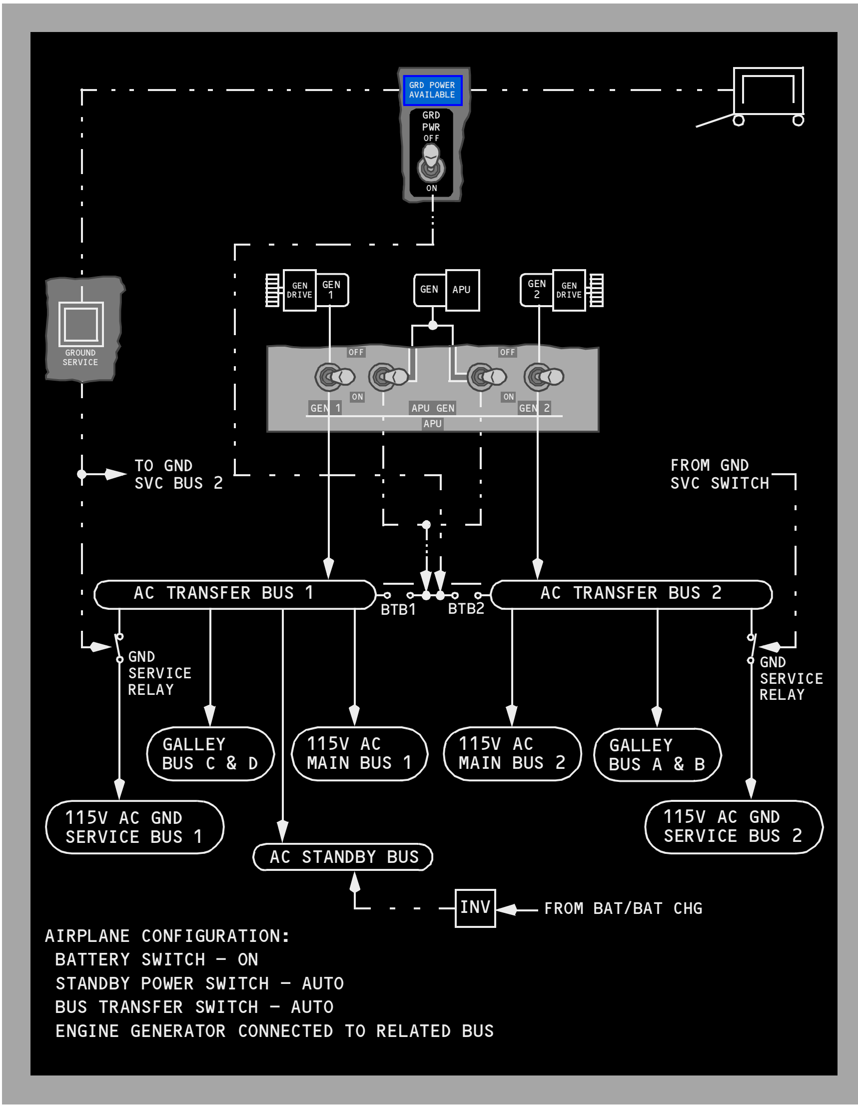
Automatic Load Shedding (Engine Generators)

For single generator operation, the system is designed to shed electrical load incrementally based on actual load sensing. The galleys and main bus on transfer bus 2 are shed first; if an overload is still sensed, the galleys and main bus on transfer bus 1 are shed; if overload still exists, the IFE buses are shed. When configuration changes to more source capacity (two generator operation), automatic load restoration of the IFE/PASS buses takes place; restoration of galley and main bus power requires reset of the CAB/UTIL switch. Manual restoration of galley and main bus power can be attempted by moving the CAB/UTIL Power Switch to OFF, then back ON.

APU Automatic Load Shedding

In flight, if the APU is the only source of electrical power, all galley buses and main buses are automatically shed. If electrical load still exceeds design limits, both IFE buses are also automatically shed. On the ground, the APU attempts to carry a full electrical load. If an overload condition is sensed, the APU sheds galley buses and main buses until the load is within limits. Manual restoration of galley and main bus power can be attempted by moving the CAB/UTIL Power Switch to OFF, then back ON.

AC Power Schematic



Electrical Power Controls and Monitoring

Generator Drive

The IDGs contain the generator and drive in a common housing, and are lubricated and cooled by a self–contained oil system. An integral electro–mechanical disconnect device provides for complete mechanical isolation of the IDG.

The generator drive (DRIVE) amber caution light is illuminated when low oil pressure is sensed in the IDG. IDG low oil pressure is caused by one of the following:

- IDG failure
- engine shutdown
- IDG automatic disconnect due to high oil temperature
- IDG disconnected through generator drive DISCONNECT switch.

A generator drive disconnect switch is installed. This switch disconnects the generator from the engine in the event of a generator drive malfunction. Reactivation of the generator may be accomplished only on the ground by maintenance personnel.

AC Voltmeter, Ammeter and Frequency Meter

AC voltage and frequency may be read on the AC voltmeter and frequency meter for standby power, ground power, generator No. 1, APU generator, generator No. 2 and the static inverter. Frequency is indicated only when the generator is electrically excited. The voltage regulator automatically controls the generator output voltage.

Current readings for the two engine IDGs and the APU generator may be read on the AC ammeter.

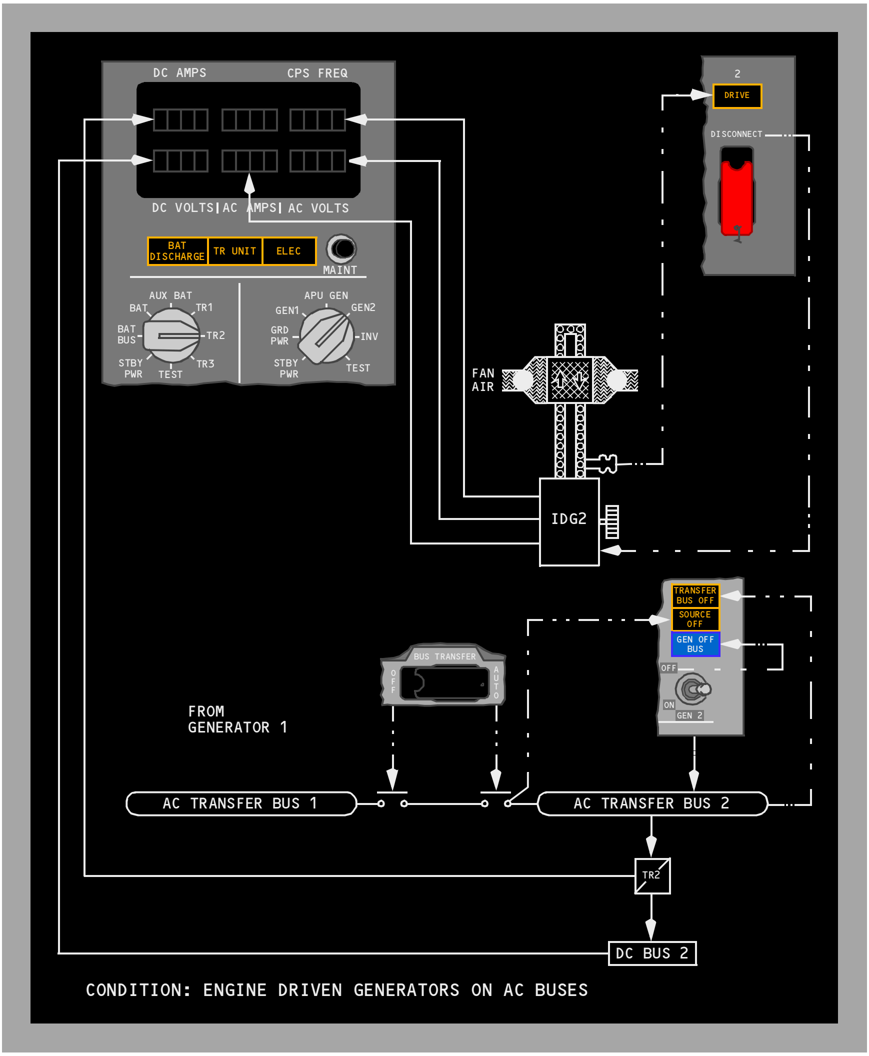
The TEST position is used by maintenance and connects the voltage and frequency meter to the power systems test module for selection of additional reading points.

DC Voltmeter and Ammeter

DC voltage and amperage may be read on the DC voltmeter and ammeter for the battery and each of the three TRs. The standby power and battery bus displays only DC voltage.

The TEST position is used by maintenance.

Electrical Power Controls and Monitoring Schematic



DC Power System

28 volt DC power is supplied by three TR units, which are energized from the AC transfer buses. The battery provides DC power to loads required to be operative when no other source is available.

On the ground, an amber ELEC light comes on to indicate that a fault exists in DC power system or standby power system. The ELEC light is inhibited in flight.

Transformer Rectifier Units

The TRs convert 115 volt AC to 28 volt DC, and are identified as TR1, TR2, and TR3.

TR1 receives AC power from transfer bus 1. TR2 receives AC power from transfer bus 2. TR3 normally receives AC power from transfer bus 2 and has a backup source of AC power from transfer bus 1. Any two TRs are capable of supplying the total connected load.

Under normal conditions, DC bus 1, DC bus 2, and the DC standby bus are connected via the cross bus tie relay. In this condition, TR1 and TR2 are each powering DC bus 1, DC bus 2, and the DC standby bus. TR3 powers the battery bus and serves as a backup power source for TR1 and TR2.

The cross bus tie relay automatically opens, isolating DC bus 1 from DC bus 2, under the following conditions:

- At glide slope capture during a flight director or autopilot ILS approach. This isolates the DC buses during approach to prevent a single failure from affecting both navigation receivers and flight control computers
- Bus transfer switch positioned to OFF.

In–flight, an amber TR UNIT light illuminates if TR1, or TR2 and TR3 has failed. On the ground, any TR fault causes the light to illuminate.

Battery Power

Dual Battery

Two 24 volt nickel–cadmium batteries, main and auxiliary, are located in the electronics compartment. The batteries can supply part of the DC system. The auxiliary battery operates in parallel with the main battery when the battery is powering the standby system. At all other times, the auxiliary battery is isolated from the power distribution system. Battery charging is automatically controlled. Two fully charged batteries have sufficient capacity to provide standby power for a minimum of 60 minutes. Battery voltage range is 22–30 volts.

DC buses powered from the battery following a loss of both generators are:

- battery bus
- DC standby bus
- hot battery bus
- switched hot battery bus.

The switched hot battery bus is powered whenever the battery switch is ON.

The hot battery bus is always connected to the battery. There is no switch in this circuit. The battery must be above minimum voltage to operate units supplied by this bus. An amber BAT DISCHARGE light comes on when excessive battery discharge is detected.

Battery Charger Transformer/Rectifier

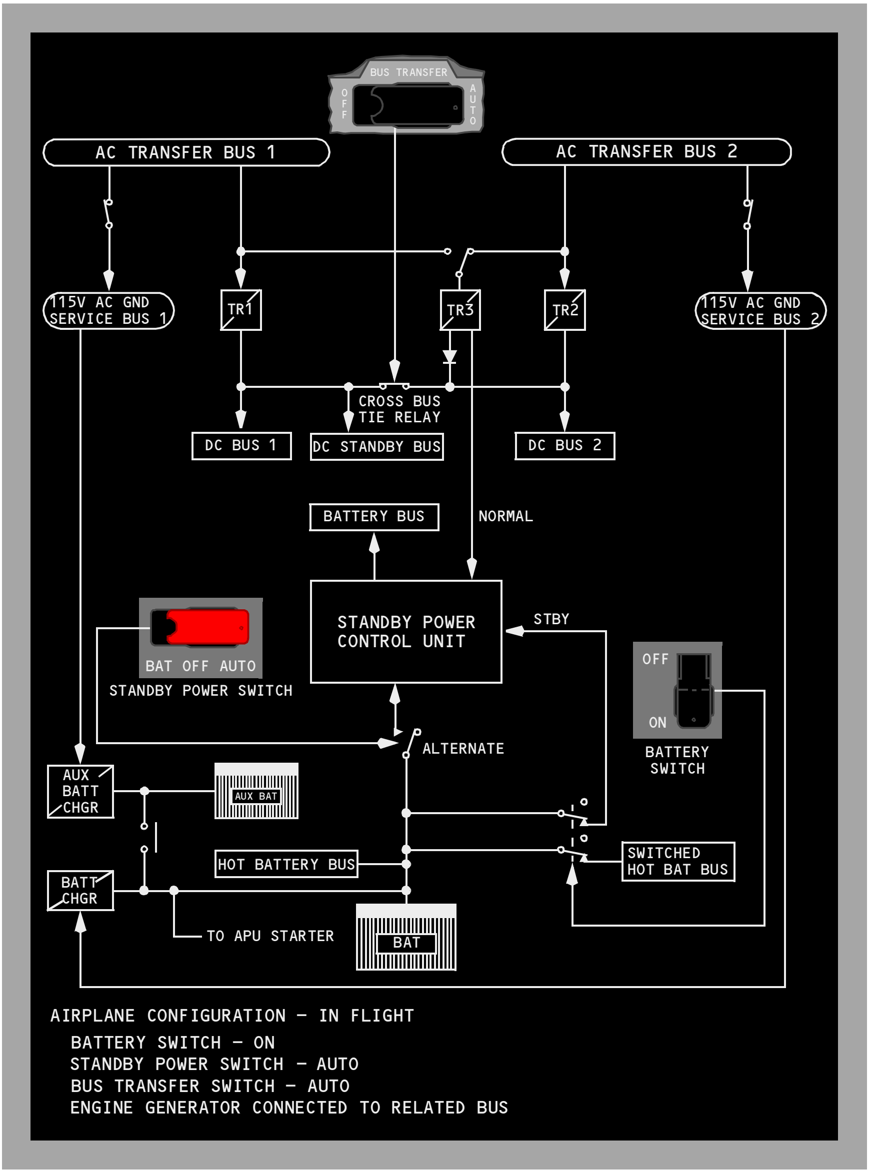
Dual Battery

The purpose of the battery chargers is to restore and maintain the batteries at full electrical power. The main battery charger is powered through AC ground service bus 2. The auxiliary battery charger is powered through AC ground service bus 1.

The battery chargers provide a voltage output tailored to maximize the battery charge. Following completion of the primary charge cycle, the main battery charger reverts to a constant voltage TR mode. In the TR mode, it powers loads connected to the hot battery bus and the switched hot battery bus. The main battery charger TR also powers the battery bus if TR3 fails. With loss of AC transfer bus 1 or the source of power to DC bus 1, the AC and DC standby buses are powered by the main and auxiliary battery/battery chargers.

The auxiliary battery charger and battery are isolated from the power distribution system under normal operation. When the main battery is powering the standby system, the auxiliary battery is connected to operate in parallel with the main battery.

DC Power System Schematic



Standby Power System
Normal Operation

The standby system provides 115V AC and 24V DC power to essential systems in the event of loss of all engine or APU–driven AC power. The standby power system consists of:

- static inverter
- AC standby bus
- DC standby bus
- battery bus
- hot battery bus
- switched hot battery bus
- main battery
- auxiliary battery.

During normal operation the guarded standby power switch is in AUTO and the battery switch is ON. This configuration provides alternate power sources in case of partial power loss as well as complete transfer to battery power if all normal power is lost. Under normal conditions the AC standby bus is powered from AC transfer bus 1. The DC standby bus is powered by TR1, TR2, and TR3; the battery bus is powered by TR3; the hot battery bus and switched hot battery bus are powered by the battery/battery charger.

Alternate Operation
Dual Battery

The alternate power sources for standby power are the main battery and auxiliary battery. With the standby power switch in the AUTO position, the loss of all engine or APU electrical power causes the batteries to power the standby loads, both in the air and on the ground. The AC standby bus is powered from the batteries via the static inverter. The DC standby bus, battery bus, hot battery bus, and switched hot battery bus are powered directly from the batteries.

The standby power switch provides for automatic or manual control of power to the standby buses.

In the AUTO position, automatic switching from normal to alternate power occurs if power from either AC transfer bus 1 or DC bus 1 is lost.

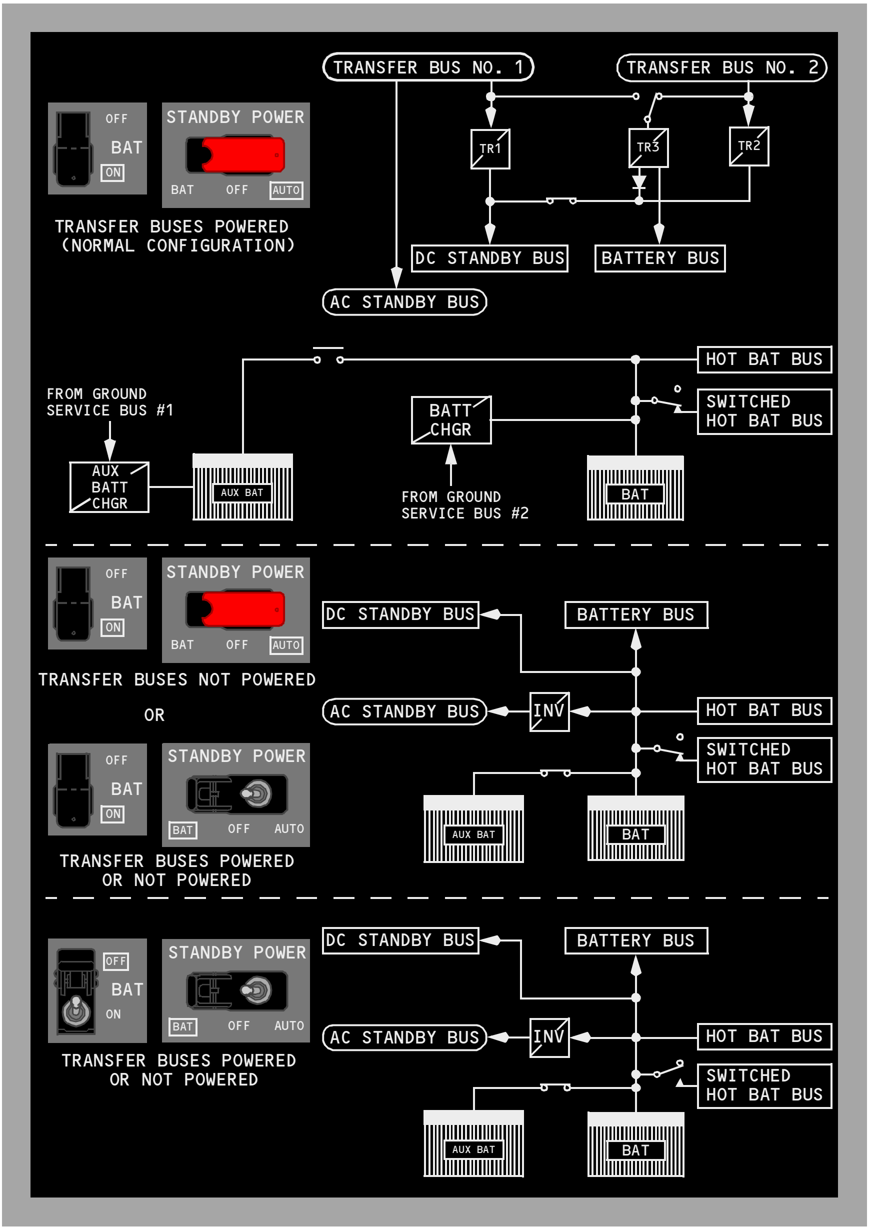
Positioning the switch to BAT overrides automatic switching and places the AC standby bus, DC standby bus, and battery bus on battery power. The battery switch may be ON or OFF. If the battery switch is OFF, the switched hot battery bus is not powered.

Positioning the standby power switch to OFF de–energizes both the AC standby bus and the DC standby bus and illuminates the STANDBY PWR OFF light.

Static Inverter

The static inverter converts 24 volt DC power from the battery to 115V AC power to supply the AC standby bus during the loss of normal electrical power. The power supply to the inverter is controlled by the standby power switch and the battery switch on the overhead panel.

Standby Power System Schematic



All Generators Inoperative

The following list identifies the significant equipment that operates when the main battery and the auxiliary battery are the only source of electrical power.

Airplane General

- standby compass light
- white dome lights
- emergency instrument flood lights
- flight crew oxygen
- passenger oxygen

Air Systems

- A/C pack valves
- BLEED lights
- manual pressurization control
- altitude warning horn

Anti-Ice

- Captain’s pitot probe heat

Communications

- flight interphone system
- service interphone system
- passenger address system
- VHF No. 1

Electrical

- STANDBY POWER OFF light

Engines, APU

- Captain’s inboard display unit

N1, N2, fuel flow, EGT, fuel quantity, oil pressure, oil temperature, oil quantity

- thrust reversers
- starter valves
- right igniters
- APU operation (start attempts not recommended above 25,000 feet)

Fire Protection

- APU and engine fire extinguisher bottles
- APU and engine fire detection system
- Cargo fire extinguisher bottles
- Wheel well fire dectection system

Flight Controls

- Ground spoilers will function in the flight position only upon landing
- Flap Position indicator - Only indicates position of right TE flaps

Flight Instruments

- Captain's outboard display unit with primary flight display.
- Captain's inboard display unit with navigation display
- Captain's clock
- left EFIS control panel
- integrated standby flight display (ISFD), standby magnetic compass

Flight Management, Navigation

- left FMC
- left CDU
- heading/track indications
- VHF NAV No. 1
- ILS No. 1
- left IRS
- GLS No.1
- left GPS
- marker beacon
- ADF No. 1
- transponder No. 1
- DME No. 1

Fuel

- crossfeed valve
- engine fuel shutoff valves
- spar fuel shutoff valve
- FUEL VALVE CLOSED lights
- fuel quantity indicators

Hydraulic Power

- engine hydraulic shutoff valves
- standby rudder shutoff valves

Landing Gear

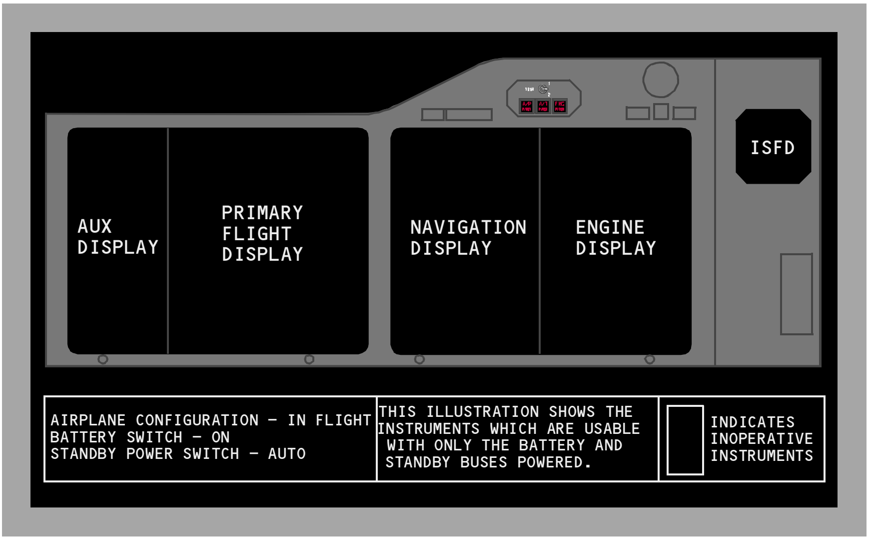
- inboard antiskid system
- ANTISKID INOP light
- parking brake
- air/ground system
- landing gear indicator lights

Warnings

- stall warning system
- aural warnings
- master caution light recall

Basic Equipment Operating – Main Panel - Captain

The standby power system utilizes the battery as a source of power to supply the below depicted flight instruments. All of the Captain's instruments that are powered by standby power are integrally lighted on standby power



Basic Equipment Operating – Main Panel - First Officer

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Engines, APU — Chapter 7
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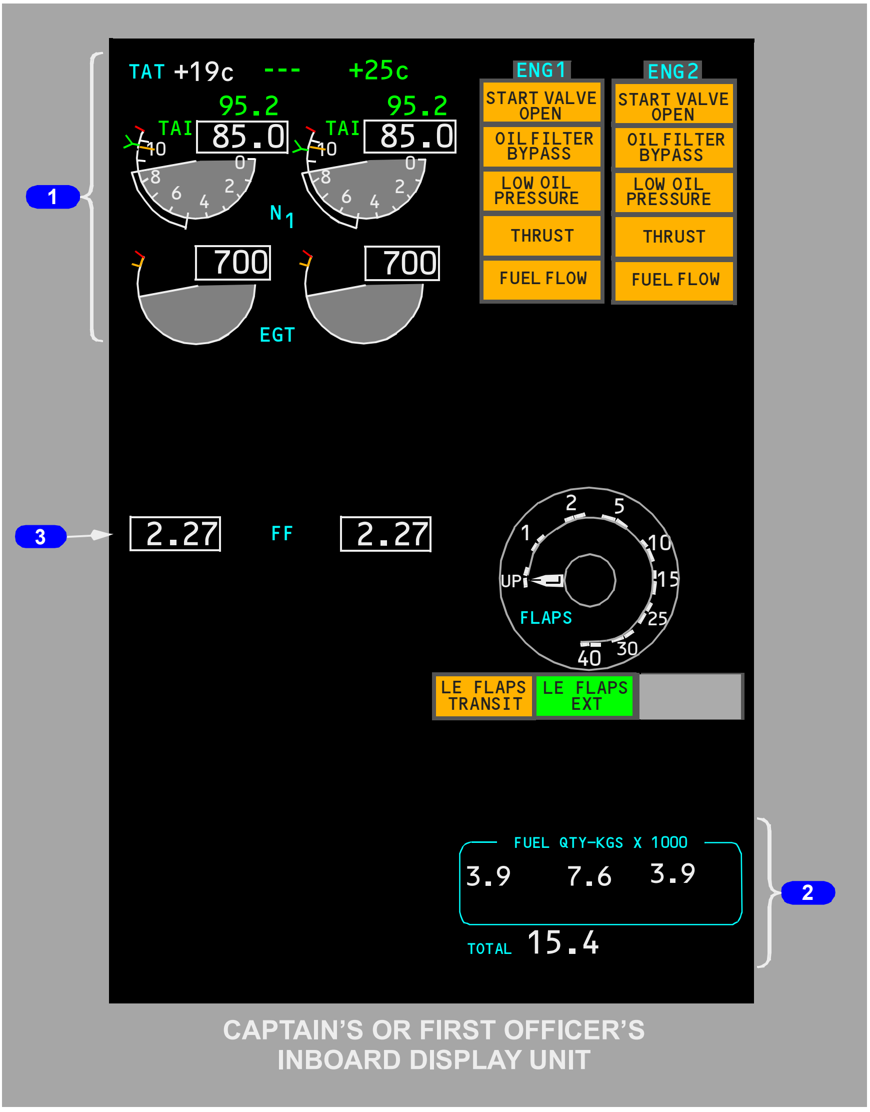
Primary Engine Indications

CAPTAIN'S OR FIRST OFFICER'S INBOARD DISPLAY UNIT



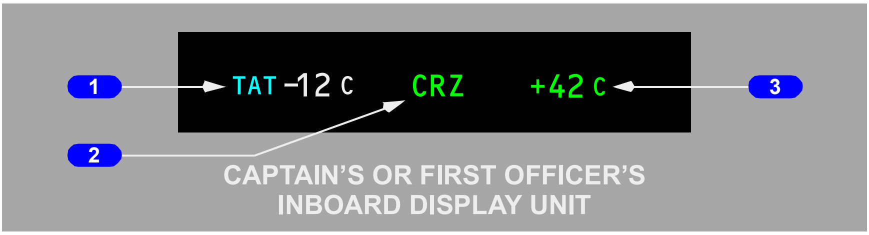
1 Primary Engine Indications

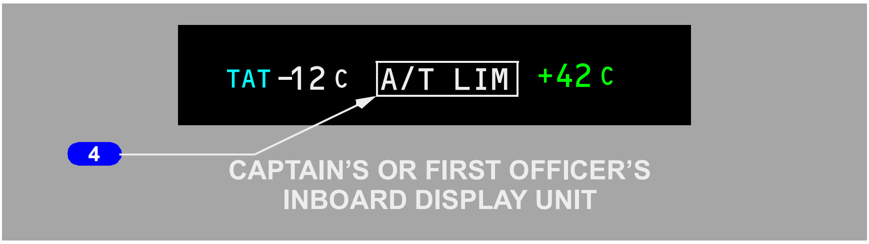
2 Fuel Quantity Indications

Refer to Chapter 12, Fuel

3 Fuel Flow Indications

Total Air Temperature, Thrust Mode Display, Selected Temperature and Autothrottle Limit





1 Total Air Temperature (TAT) Indication

Displayed (label – cyan, temp – white) – total air temperature (degrees C).

2 Thrust Mode Display

Displayed (green) – the active N1 limit reference mode.

Active N1 limit is normally calculated by FMC.

Thrust mode display annunciations are:

- TO – takeoff
- TO 1 – derated takeoff one
- TO 2 – derated takeoff two
- D-TO – assumed temperature reduced thrust takeoff
- D-TO 1 – derate one and assumed temperature reduced thrust takeoff
- D-TO 2 – derate two and assumed temperature reduced thrust takeoff
- TO B – takeoff bump thrust (as installed)
- CLB – climb
- CLB 1 – derated climb one
- CLB 2 – derated climb two
- CRZ – cruise
- MAN– manual N1 setting
- G/A – go–around
- CON – continuous
- —— – FMC not computing thrust limit.

3 Selected Temperature

Displayed (green) – selected assumed temperature (degrees C) for reduced thrust takeoff N1.

Repeats data selected on TAKEOFF REF page.

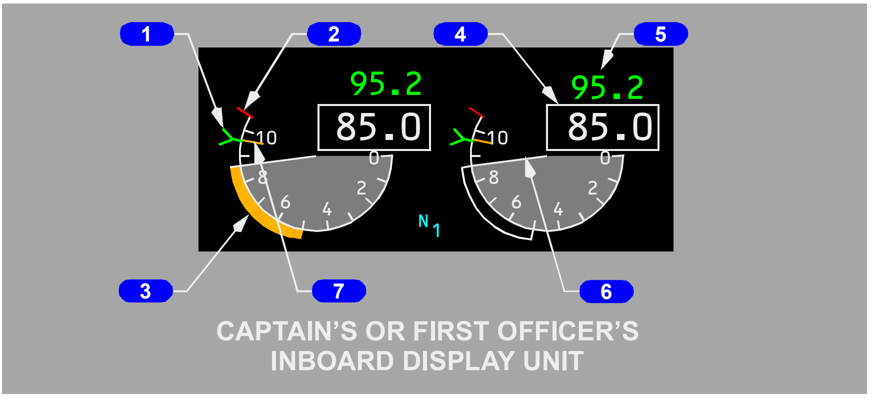
4 Autothrottle Limit (A/T LIM) Indication

Illuminated (white) – The A/T computer is calculating a degraded N1 thrust limit for the affected engine(s).

Replaces thrust mode display annunciation when illuminated.

Displayed on ground, when autothrottles disconnected.

N1 Indications



1 Reference N1 Bugs

Displayed (green)

Position corresponds to digital value on the Reference N1 Readout.

2 N1 Redlines

Displayed (red) – N1% RPM operating limit

3 N1 Command Sectors

Displayed (white unfilled) – momentary difference between actual N1 and value commanded by thrust lever position.

Displayed (amber filled) –

- the thrust is more than the commanded thrust; or
- the thrust is less than the commanded thrust
- displayed in conjunction with THRUST alert for affected engine.

4 N1 RPM Readouts (digital)

Displayed (white) – normal operating range.

Displayed (red) –

- operating limit exceeded
- on ground after engine shutdown, red box indicates an inflight exceedance has occurred.

5 Reference N1 Readouts

Displayed (green) –

- manually set N1% RPM when N1 SET is not in the AUTO selection in the N1/SPD REF SET display
- – – – – when N1 SET is in the AUTO selection in the N1/SPD REF SET display and FMC source invalid
- when N1 SET is in the AUTO selection in the N1/SPD REF SET display, indicates fixed derate, assumed temperature derate, or a combination of fixed and assumed temperature derate

Not Displayed when Reverse Thrust is selected.

6 N1 RPM Indications

Displays N1% RPM:

- displayed (white) – normal operating range
- displayed (red) – operating limit exceeded.

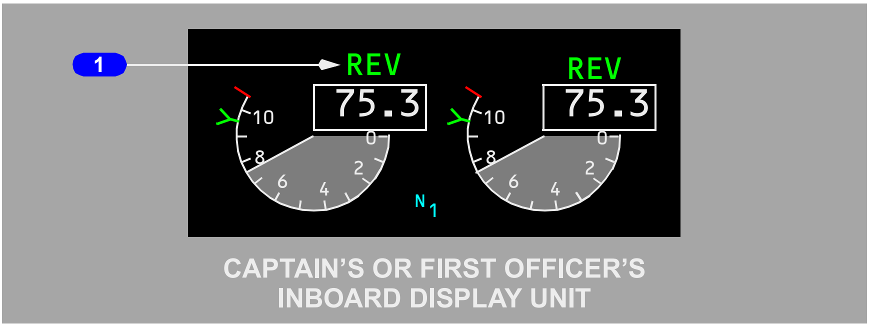
7 N1 Maximum Bug

Displayed (amber) –

- N1 value for full rated thrust
- computed by the EEC through all phases of flight.
- upper limit for autothrottle operation.

Not displayed when reverse thrust is selected.

Thrust Reverser Indications

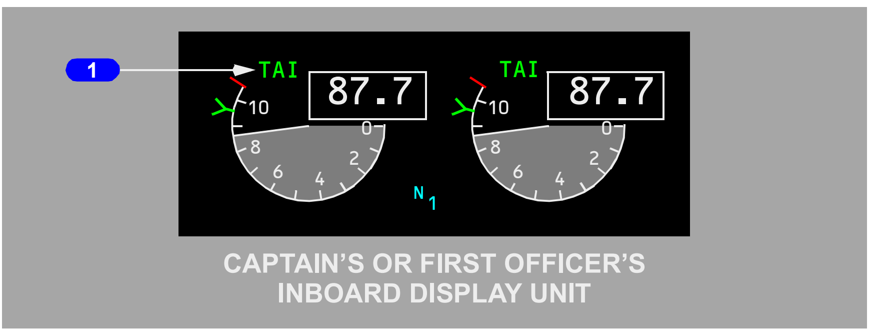


1 Thrust Reverser (REV) Indications

Displayed (amber) – thrust reverser is moved from stowed position.

Displayed (green) – thrust reverser is deployed.

Thermal Anti–Ice Indication

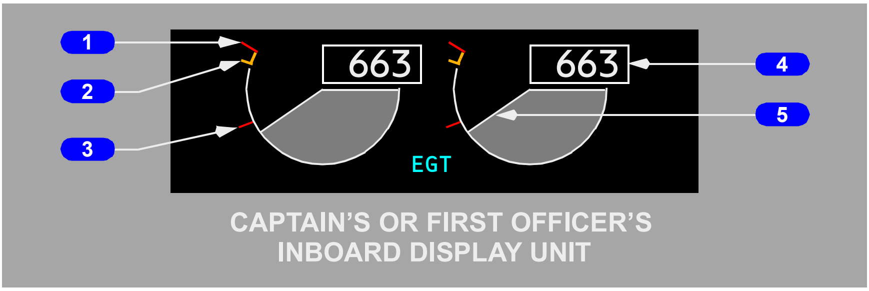


1 Thermal Anti–Ice (TAI) Indications

Displayed (green) – cowl anti–ice valve(s) open.

Displayed (amber) – cowl anti–ice valve is not in position indicated by related engine anti–ice switch.

EGT Indications



1 Exhaust Gas Temperature (EGT) Redlines

Displayed (red) –

- maximum takeoff EGT limit.
- maximum in-flight start EGT limit when the start limit redline is not shown.

2 Exhaust Gas Temperature (EGT) Amber Bands

Displayed (amber) – lower end of band displays maximum continuous EGT limit.

3 Exhaust Gas Temperature (EGT) Start Limit Redlines

Displayed (red) –

- until the engine achieves stabilized idle (approximately 66% N2).
- for ground starts and some in-flight starts as determined by the EEC.

4 Exhaust Gas Temperature (EGT) Readouts (digital)

Displayed (white) – normal operating range (degrees C)

Displayed (amber) – maximum continuous limit exceeded; color change inhibited for up to 5 minutes during takeoff or go-around

Displayed (red) – maximum takeoff limit or start limit exceeded

On ground, after both engines are shut down, red box indicates an exceedance has occurred

Displayed (white-blinking) EEC senses conditions that may lead to hot start or stall during ground starting. EEC software will automatically cut fuel for an impending hot start or stall during ground starting.

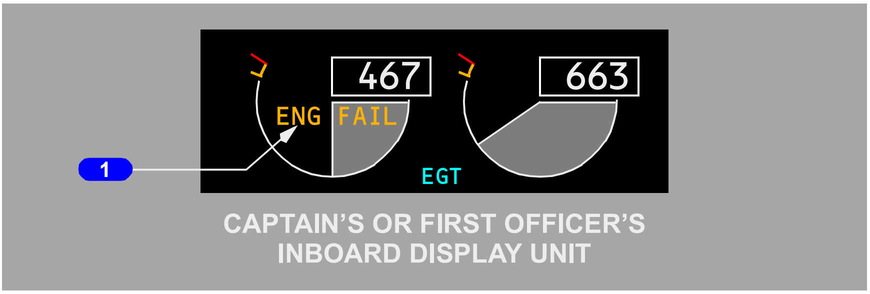
5 Exhaust Gas Temperature (EGT) Indications

Displayed (white) – normal operating range.

Displayed (amber) – maximum continuous limit exceeded; color change inhibited for up to 5 minutes during takeoff or go–around

Displayed (red) – maximum takeoff limit or start limit exceeded.

Engine Fail Alert



1 Engine Fail (ENG FAIL) Alert

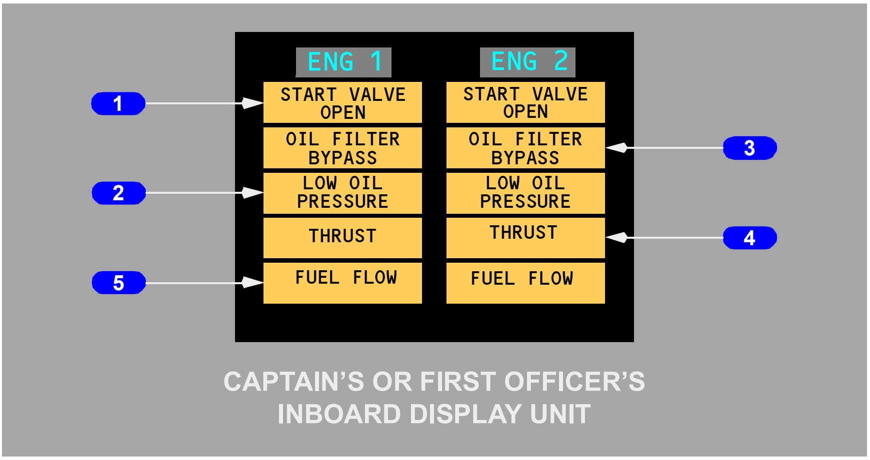
Displayed (amber) –

- engine operating below sustainable idle (approximately 63%); and
- engine start lever in IDLE position.

Alert remains until –

- engine recovers; or
- start lever moved to CUTOFF; or
- engine fire switch pulled.

Crew Alerts



1 **START VALVE OPEN Alert**

Illuminated (amber) –

- steady – respective engine start valve open and air is supplied to starter
- blinking – uncommanded opening of start valve. The alert and entire block will blink for 10 seconds and then the alert only will remain steady until the condition no longer exists (see Note).

2 **LOW OIL PRESSURE Alert**

Illuminated (amber) –

- steady – oil pressure at or below red line
- blinking – with a condition of low oil pressure. The alert and entire block will blink for 10 seconds and then the alert only will remain steady until the condition no longer exists (see Note).

3 **OIL FILTER BYPASS Alert**

Illuminated (amber) –

- steady – indicates an impending bypass of oil supply filter
- blinking – with an impending bypass. The alert and entire block will blink for 10 seconds and then the alert only will remain steady until the condition no longer exists (see Note).

4 **THRUST Alert**

Illuminated (amber) –

- steady
  - the thrust is more than the commanded thrust; or
  - the thrust is less than the commanded thrust
  - displayed in conjunction with amber N1 command sector for affected engine.
- blinking – with a condition of more than or less than commanded thrust. The alert and entire block will blink for 10 seconds and then the alert only will remain steady until the condition no longer exists (see Note).

5 FUEL FLOW Alert

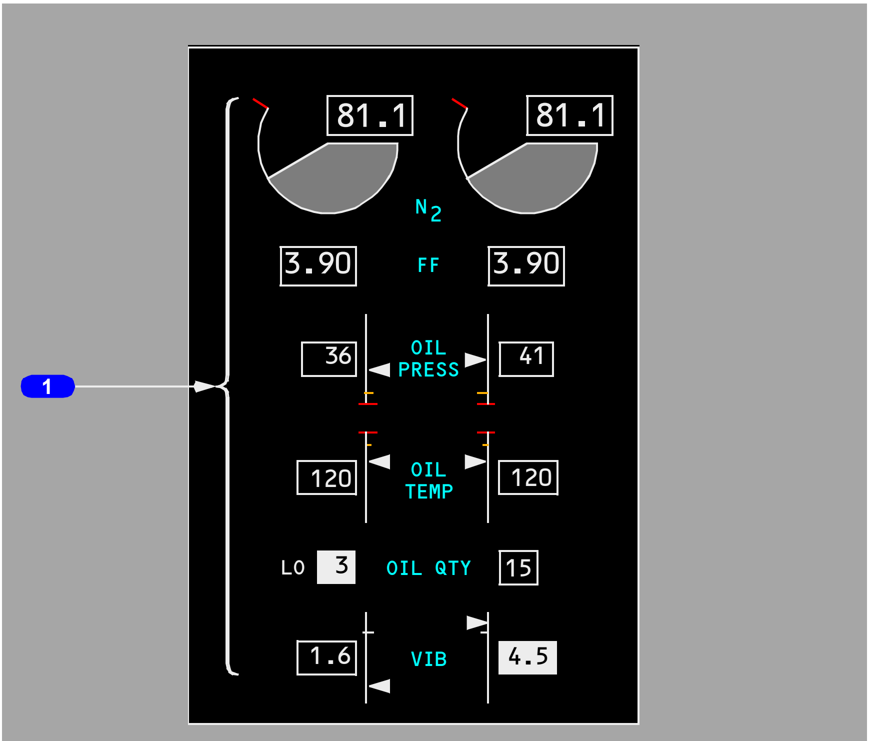
Illuminated (amber) –

- steady – engine fuel flow is abnormally high when compared to the FMC expected fuel flow.
- blinking – with fuel flow abnormally high, the alert and entire block will blink for 10 seconds and then the alert only will remain steady until the condition no longer exists (see Note).

Note: Blinking is inhibited:

- during takeoff from 80 knots to 400 feet RA, or 30 seconds after reaching 80 knots, whichever occurs first
- during landing below 200 feet RA until 30 seconds after touchdown
- during periods when blinking is inhibited, alerts illuminate steady.

Secondary Engine Indications



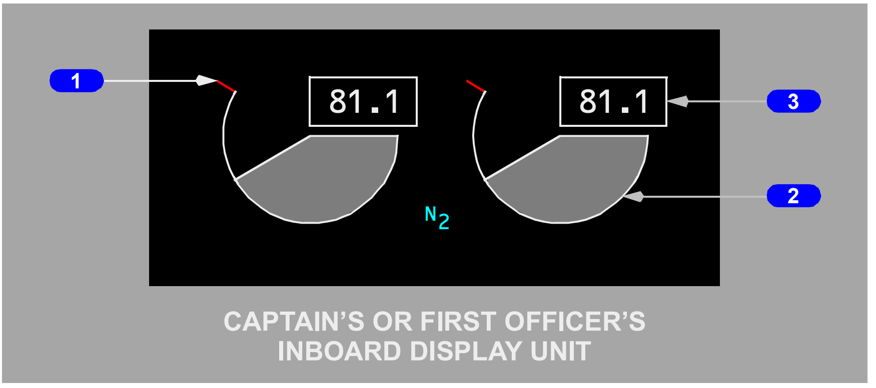
CAPTAIN'S OR FIRST OFFICER'S
INBOARD DISPLAY UNIT

1 Secondary Engine Indications

Secondary engine indications are displayed:

- when MDS initially receives power
- when selected by the Multi-Function Display (MFD)
- in flight when an Engine Start Lever is moved to CUTOFF
- in flight when an engine N2 rpm is below idle rpm (ENG FAIL)
- when a secondary engine parameter exceeds normal operating range.

N2 Indications



1 N2 Redlines

Displayed (red) – N2% RPM operating limit.

2 N2 RPM Indications

Displays N2% RPM

- displayed (white) – normal operating range
- displayed (red) – operating limit exceeded.

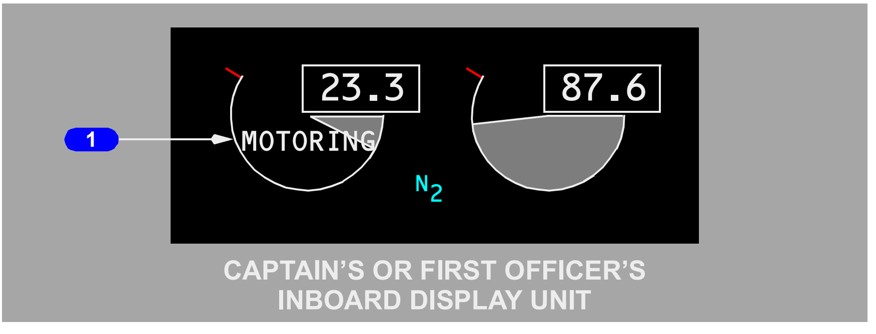
3 N2 Readouts (digital)

Displayed (white) – normal operating range.

Displayed (red) –

- operating limit exceeded
- on ground, after engine shutdown, red box indicates an inflight exceedance has occurred.

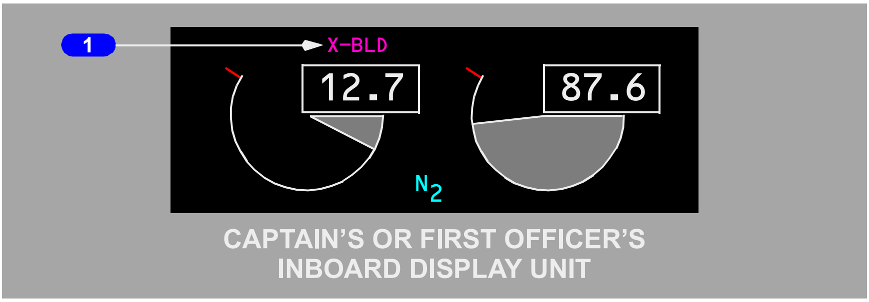
Motoring Indication



1 MOTORING Indication

Displayed (white) – Bowed Rotor Motoring (BRM) logic is active during engine start on the ground.

Crossbleed Start Indication

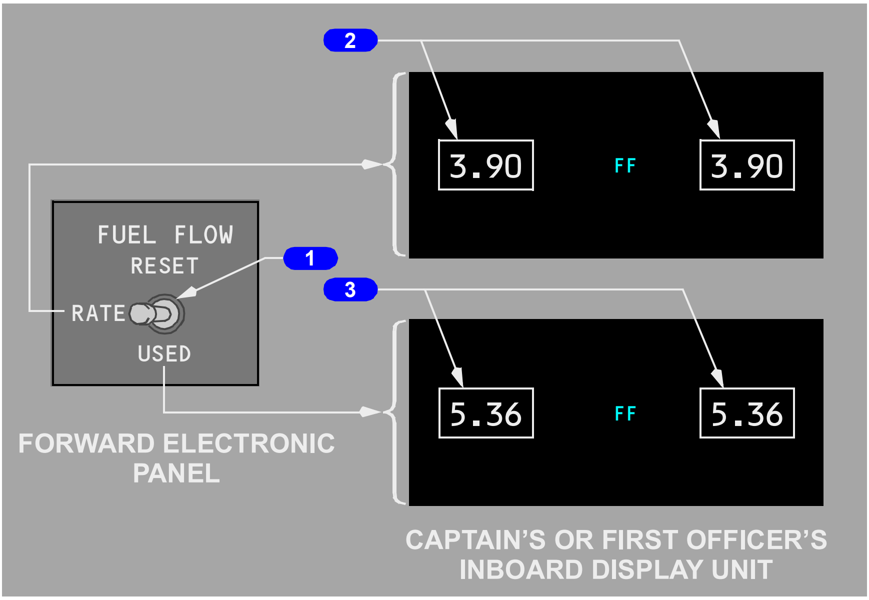


1 Crossbleed Start (X–BLD) Indication

Displayed (magenta) – crossbleed air recommended for inflight start.

Displayed when airspeed is less than required for a windmilling start.

Fuel Flow/Fuel Used Indications



1 **FUEL FLOW Switch (spring-loaded to RATE)**

RATE – displays fuel flow to engine.

USED –

- displays fuel used since last reset
- after 10 seconds, display automatically reverts to fuel flow.

Note: APU fuel used is not included.

RESET –

- resets fuel used to zero
- displays fuel used for 1 second, decreases to zero, then displays fuel flow.

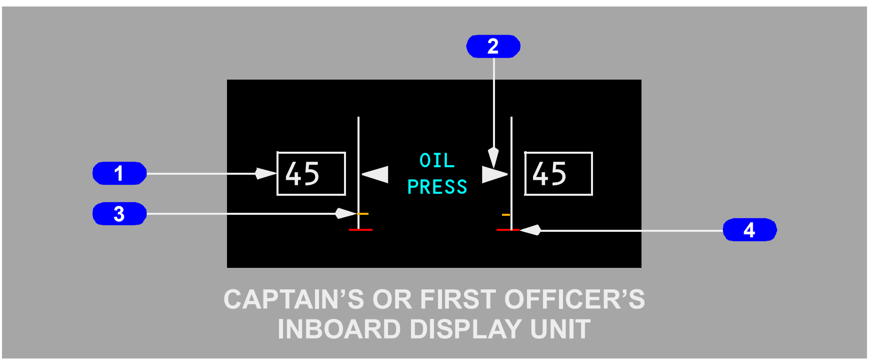
2 **Fuel Flow (FF) Readout (digital)**

Displayed (white) – fuel flow to engine with FUEL FLOW switch in RATE position (kilograms per hour x 1000).

3 **Fuel Used Readout (digital)**

Displayed (white) – when FUEL FLOW switch moved to USED or RESET.

Oil Pressure Indications



1 **Oil Pressure (OIL PRESS) Readout**

Displays engine oil pressure (psi)

- displayed (white) – normal operating range
- displayed (amber) – caution range
- displayed (red) – operating limit reached.

2 **Oil Pressure (OIL PRESS) Pointer**

Displays engine oil pressure:

- displayed (white) – normal operating range
- displayed (amber) – caution range reached
- displayed (red) – operating limit reached.

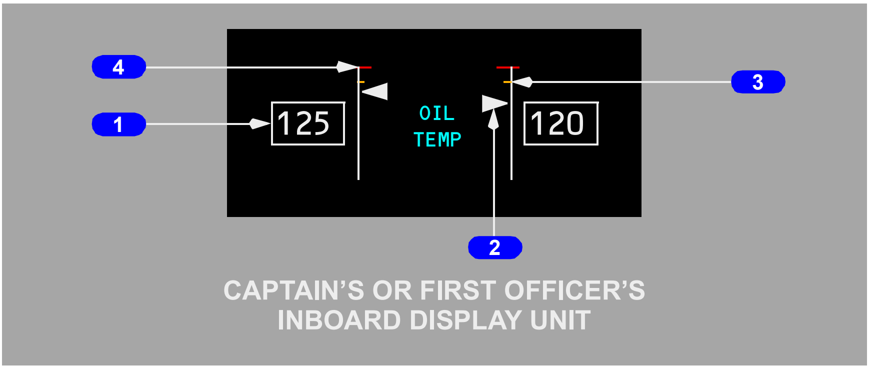
3 **Low Oil Pressure (OIL PRESS) Amber Band**

Displayed (amber) – low oil pressure caution range.

4 **Low Oil Pressure (OIL PRESS) Redline**

Displayed (red) – oil pressure operating limit.

Oil Temperature Indications



1 **Oil Temperature (OIL TEMP) Readout**

Displays oil temperature (degrees C):

- displayed (white) – normal operating range
- displayed (amber) – caution range reached
- displayed (red) – operating limit reached.

2 **Oil Temperature (OIL TEMP) Pointer**

Displays oil temperature (degrees C):

- displayed (white) – normal operating range
- displayed (amber) – caution range reached
- displayed (red) – operating limit reached.

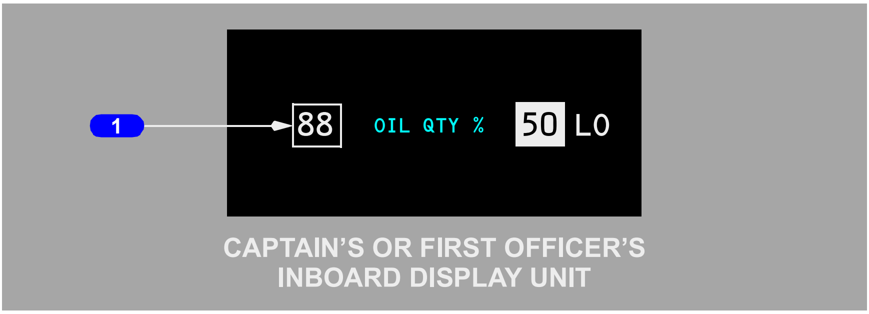
3 **High Oil Temperature (OIL TEMP) Amber Band**

Displayed (amber) – oil temperature caution range.

4 **High Oil Temperature (OIL TEMP) Redline**

Displayed (red) – oil temperature operating limit.

Oil Quantity Indications



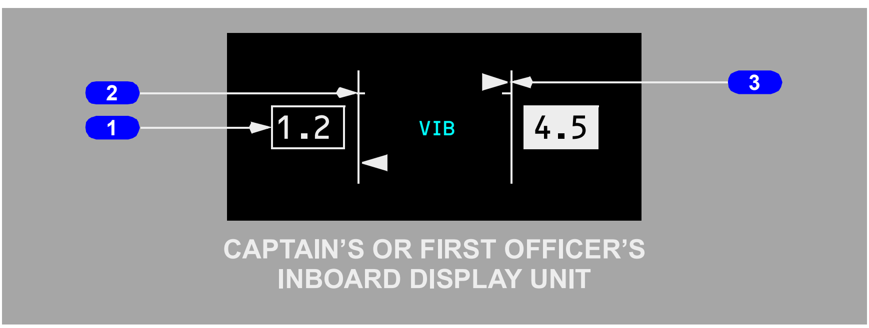
1 **Oil Quantity (OIL QTY %) Readout**

Displays usable oil quantity as a percentage of full quantity.

Note: Indicated oil quantity may decrease during engine start, takeoff and climb out. If this occurs, engine operation is not impacted.

Video is reversed and LO (white) displayed for low oil quantity.

Engine Vibration Indications



1 **Vibration (VIB) Readout**

Displayed (white) – engine vibration level.

Video is reversed for high vibration.

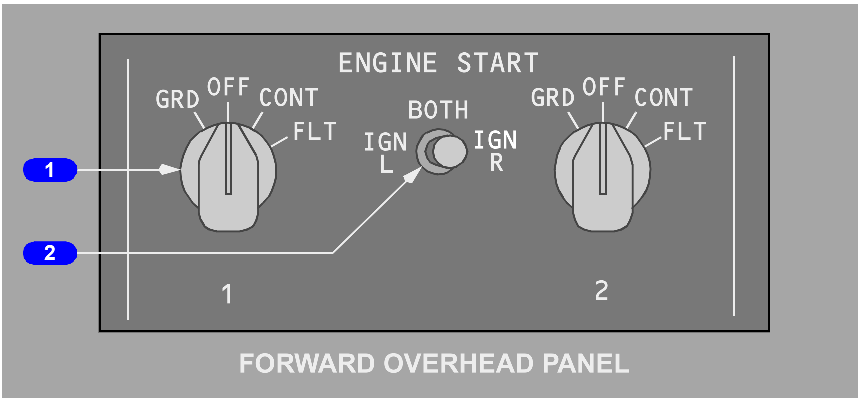
2 **High Limit**

Displays tick mark and thick line.

3 **Vibration (VIB) Pointer**

Displayed (white) – engine vibration level.

Engine Start Switches



1 **ENGINE START Switches**

GRD –

- opens start valve
- closes engine bleed valve
- for ground starts, arms selected igniter(s) to provide ignition when engine start lever is moved to IDLE
- for inflight starts, arms both igniters to provide ignition when engine start lever is moved to IDLE
- releases to OFF at starter cutout.

OFF –

- ignition normally off
- both igniters are activated when engine start lever is in IDLE and:
  •an uncommanded rapid decrease in N2 occurs or,
  •N2 is between 65% and 50% or,
  •in flight - N2 is between idle and 5%.

CONT –

- provides ignition to selected igniters when engine is operating and engine start lever is in IDLE
- in flight - provides ignition to both igniters when N2 is below idle and engine start lever is in IDLE.

FLT – provides ignition to both igniters when engine start lever is in IDLE.

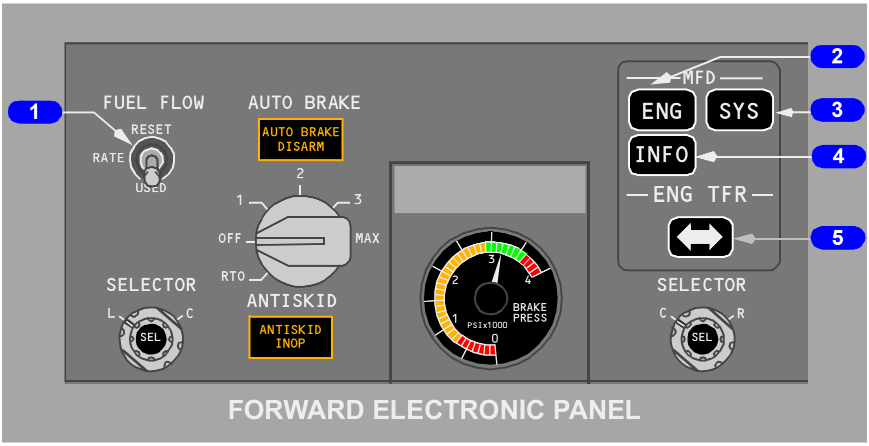
2 Ignition Select Switch

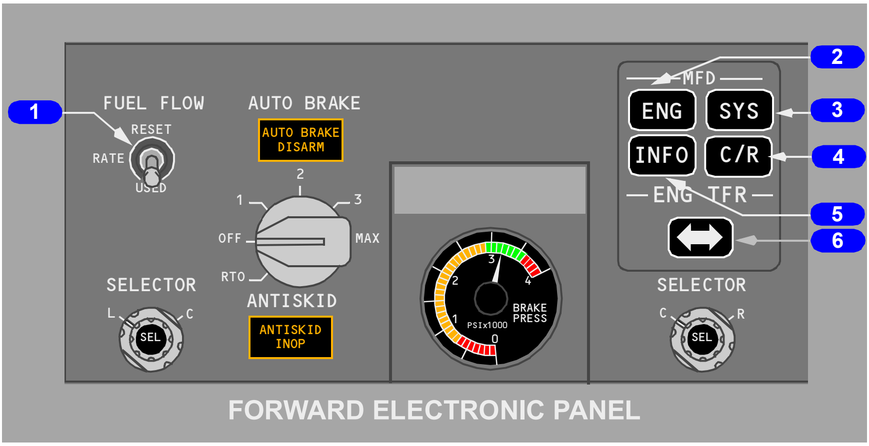
IGN L – selects the left igniter for use on both engines.

BOTH – selects both igniters for use on both engines.

IGN R – selects the right igniter for use on both engines.

Engine Display Control Panel





1 FUEL FLOW Switch

Refer Fuel Flow/Fuel Used Indications

2 **MFD Engine (ENG) Switch**

Push – ENG

- displays secondary engine indications on MDS
- second push removes secondary engine indication from MDS.

3 **MFD System (SYS) Switch**

Refer to:

- Chapter 13, Hydraulics
- Chapter 9, Flight Controls
- Chapter 14, Landing Gear

4 **MFD Cancel/Recall (C/R) Switch (as installed)**

Refer to Chapter 15, Warning Systems.

4 **MFD Information (INFO) Switch**

Refer to Chapter 10, Flight Instruments

5 **MFD Information (INFO) Switch**

Refer to Chapter 10, Flight Instruments

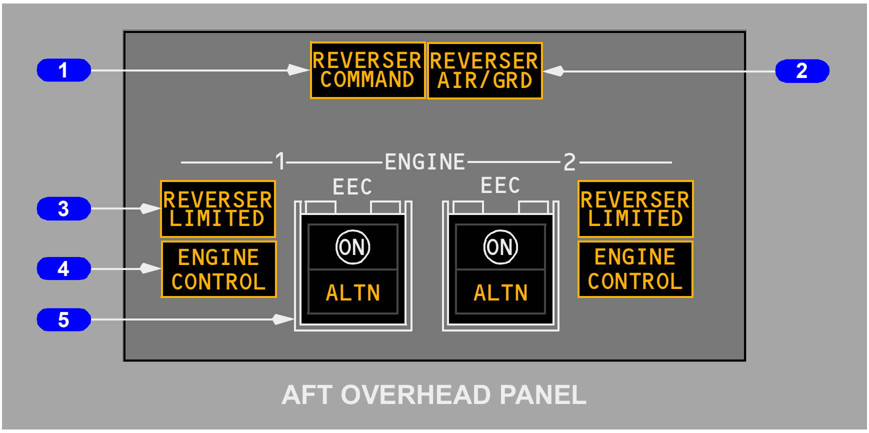
5 **Engine Transfer (ENG TFR) Switch**

Push – moves the engine indications to either the Captain's or the First Officer's inboard display unit.

6 **Engine Transfer (ENG TFR) Switch**

Push – moves the engine indications to either the Captain's or the First Officer's inboard display unit.

Engine Panel



1 REVERSER COMMAND Light

Illuminated (amber) – the reverse thrust lever is not in the down position in flight.

2 REVERSER AIR/GRD Light

Illuminated (amber) – the air/ground thrust reverser logic is failed.

3 REVERSER LIMITED Lights

Illuminated (amber) –

- on the ground
  - A fault has occurred in the thrust reverser system
- in-flight
  - A fault in the thrust reverser system limits reverse thrust. Thrust reverser will not deploy or reverse thrust will be limited to idle.

4 ENGINE CONTROL Lights

Illuminated (amber) – engine control system is not dispatchable due to faults in system.

Light operates when:

- engine is operating and,
- airplane on ground and:
  - below 80 kts prior to takeoff or,
  - approximately 30 seconds after touchdown.

5 Electronic Engine Control (EEC) Switches

ON – in view (white)

- indicates normal control mode is selected
- engine ratings calculated by EEC from sensed atmospheric conditions and bleed air demand
- when ON is not in view, the EEC has been manually selected to the alternate mode.

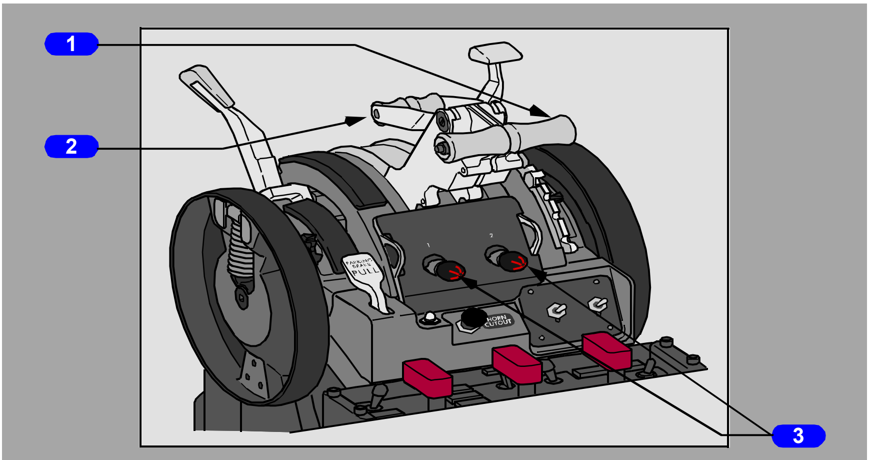
ALTN – in view (amber)

- indicated EEC has automatically switched to alternate control mode or it has been selected manually
- EEC provides rated thrust or higher.

Note: Both ON and ALTN may be in view if EEC has automatically switched to soft alternate mode.

Note: EGT limits must be observed in both normal and alternate control modes.

Engine Controls



CONTROL STAND

1 Forward Thrust Levers

- controls engine thrust
- cannot be advanced if the reverse thrust lever is in the deployed position.

2 Reverse Thrust Levers

- controls engine reverse thrust
- cannot select reverse thrust unless related forward thrust lever is at IDLE.

Note: Reverse thrust lever is blocked at reverse idle position until related thrust reverser is more than 60% deployed.

Note: Movement of reverse thrust lever into reverse thrust engages locking pawl preventing forward thrust lever from moving. Terminating reverse thrust removes locking pawl and restores forward thrust lever movement ability.

3 Engine Start Levers

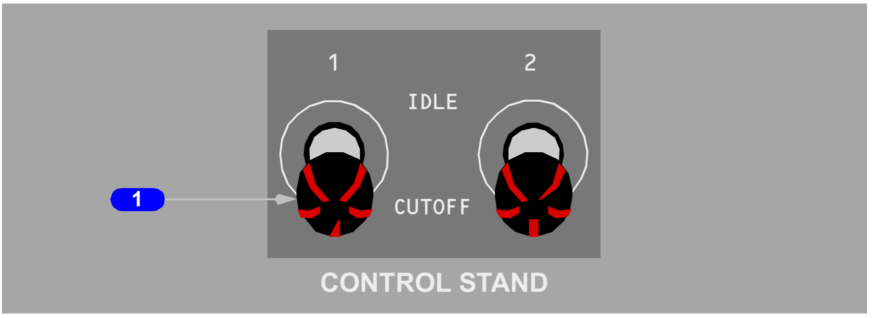
IDLE –

- energizes ignition system through EEC
- electrically opens spar fuel shutoff valve in the wing leading edge outboard of the pylon
- electrically opens engine–mounted fuel shutoff valve via the EEC.

CUTOFF –

- closes both spar and engine fuel shutoff valves
- de–energizes ignition system.

Engine Start Levers



1 Engine Start Levers

IDLE –

- energizes ignition system through EEC
- electrically opens spar fuel shutoff valve in the wing leading edge outboard of the pylon
- electrically opens engine–mounted fuel shutoff valve via the EEC.

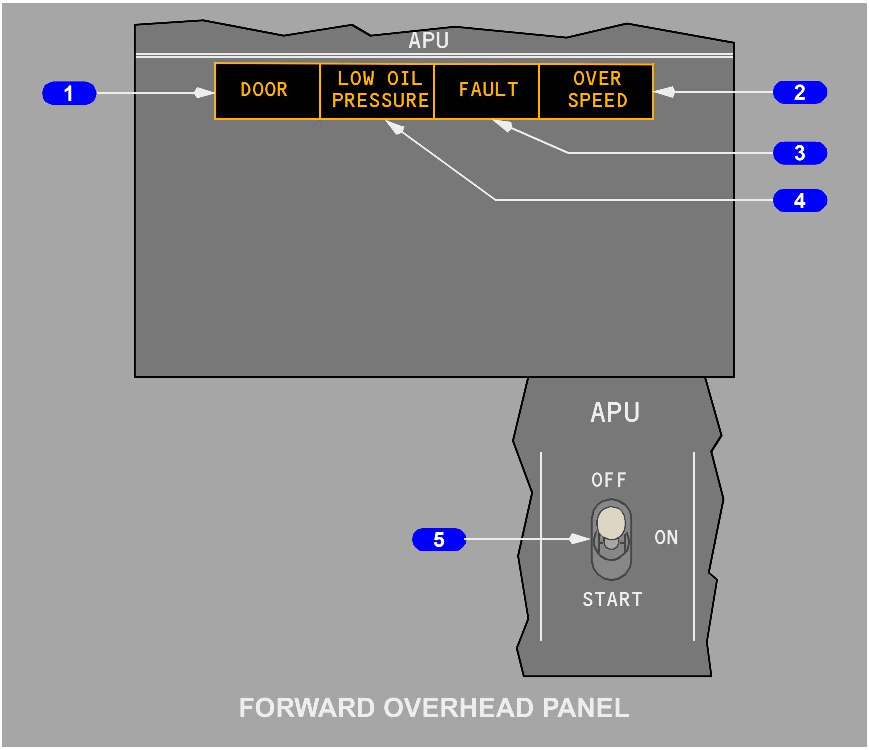
CUTOFF –

- closes both spar and engine fuel shutoff valves
- de–energizes ignition system.

Note: Illuminate (red) in the event of engine fire or during an engine fire test.

CAUTION: Do not apply rotational force when moving the engine start lever.

APU



1 APU Door (DOOR) Light

Illuminated (amber) – APU door is not in the commanded position:

- APU door is open when APU is shut down (in air or on ground)
- in flight - door is not in flight position
- on ground - door is not in ground position.

2 APU OVERSPEED Light

Illuminated (amber) –

- APU RPM limit has been exceeded resulting in an automatic shutdown
- overspeed shutdown protection feature has failed a self–test during a normal APU shutdown
- if light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes
- light is disarmed when the APU switch is in OFF position.

3 APU FAULT Light

Illuminated (amber) –

- a malfunction exists causing APU to initiate an automatic shutdown
- if light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes
- light is disarmed when APU switch is in OFF position.

4 APU LOW OIL PRESSURE Light

Illuminated (amber) –

- during start until the APU oil pressure is normal
- oil pressure is low causing an automatic shutdown (after start cycle is complete)
- if light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes
- light is disarmed when APU switch is in OFF position.

5 APU Switch

OFF – normal position when APU is not running

- positioning switch to OFF with APU running trips APU generator off the bus(es), if connected, and closes APU bleed air valve. APU continues to run for a 60 second cooling period
- APU air inlet door automatically closes after shutdown.

ON – normal position when APU is running.

START (momentary) – positioning APU switch from OFF to START and releasing it to ON initiates an automatic start sequence.

Introduction

The airplane is powered by two LEAP-1B engines. The engine is a dual–rotor, axial–flow turbofan. The N1 rotor consists of a fan, a low–pressure compressor and a low–pressure turbine. The N2 rotor consists of a high–pressure compressor and a high–pressure turbine. The N1 and N2 rotors are mechanically independent. The N2 rotor drives the engine gearboxes. A bleed–air–powered starter motor is connected to the N2 rotor.

A dual–channel electronic engine control (EEC) regulates each engine. The EEC monitors autothrottle and flight crew inputs to automatically set engine thrust.

Each engine has individual flight deck controls. Thrust is set by positioning the thrust levers. The thrust levers are positioned automatically by the autothrottle system or manually by the flight crew. The forward thrust levers control forward thrust from idle to maximum. The reverse thrust levers control thrust from reverse idle to maximum reverse

Engine Indications

Primary and secondary engine indications are provided. Engine indications are displayed on the main panel Captain’s or First Officer’s inboard DU.

Primary Engine Indications

N1 and EGT are the primary engine indications. The primary engine indications are normally displayed on the Captain’s inboard DU. The primary engine indications can also be manually selected to the First Officer’s inboard DU using ENG TFR button on the Engine Display Control Panel. If there is a failure on the Captain’s or First Officer’s DU, the display automatically moves to the opposite DU.

Secondary Engine Indications

N2, fuel flow, oil pressure, oil temperature, oil quantity, and engine vibration are the secondary engine indications. The secondary engine indications, except for fuel flow, are manually selected to either the Captain’s or First Officer’s inboard DU using the ENG switch on the Engine Display Control Panel. Fuel flow is displayed full time on the selected inboard display unit below the primary engine indications.

The secondary engine indications are automatically displayed when:

- the displays initially receive electrical power
- in flight when an Engine Start Lever is moved to CUTOFF

- in flight when an engine N2 RPM is below idle
- a secondary engine parameter is exceeded.

When the secondary engine indications are automatically displayed, they cannot be cleared until the condition is no longer present.

Normal Display Format

N1, EGT, and N2 are displayed as both digital readouts and round dial/moving pointer indications. The digital readouts display numerical values while the moving pointers indicate relative value.

Oil pressure, oil temperature, and engine vibration indications are both digital readouts and vertical indication/moving pointers. Fuel flow and oil quantity are digital readouts only. All digital readouts are enclosed by boxes.

The dials and vertical indications display the normal operating range, caution range, and operating limits.

Normal operating range is displayed on a dial or vertical indication in white.

N1, EGT, and N2 have operating limits indicated by redlines. EGT also displays an amber caution limit. If one of these indications exceeds the red or amber line, the digital readout, box, pointer, and indicator change color to red or amber.

The oil temperature and oil pressure vertical indications have a caution range and an operating limit redline. If the oil temperature or pressure reaches the caution range, the digital readout, digital readout box, and pointer all change color to amber. If one of these indications reach the operating limit, the digital readout, digital readout box, and pointer all change color to red.

The EEC must receive electrical power to supply engine operating data to the flight deck engine indications. When the EEC is not powered, N1, N2 and oil quantity are displayed directly from the engine sensors. Positioning the engine start switch to GRD supplies electrical power to the EEC and displays pointers/digits for all engine parameters.

An engine failure alert indication (ENG FAIL) is displayed in amber on the EGT indicator when the respective engine is operating at a condition below sustainable idle (63% N2) and the engine start lever is in the IDLE position. The alert remains until the engine recovers, the engine start lever is moved to CUTOFF, or the engine fire switch is pulled.

Electronic Engine Control (EEC)

Each engine has a full authority digital EEC. Each EEC has two independent control channels, with automatic channel transfer if the operating channel fails. With each engine start or start attempt, the EEC alternates between control channels. The EEC uses thrust lever inputs to automatically control forward and reverse thrust. N1 is used by the EEC to set thrust in two control modes: normal and alternate. Manual selection of the control mode can be made with the EEC switches on engine panel.

EEC Normal Mode

In the normal mode, the EEC uses sensed flight conditions and bleed air demand to calculate N1 thrust ratings. The EEC compares commanded N1 to actual N1 and adjusts fuel flow to achieve the commanded N1.

The full rated takeoff thrust for the installed engine is available at a thrust lever position less than the forward stop. Fixed or assumed temperature derated takeoff thrust ratings are set at thrust lever positions less than full rated takeoff. The EEC limits the maximum thrust according to the airplane model as follows:

Note: Typical engine ratings based on model/series airplane. For actual engine ratings refer to Performance Dispatch chapter.

- 737-8 – LEAP-1B27 rating
- 737-8 – LEAP-1B28 rating
- 737-8 – LEAP-1B28B1 rating

Takeoff Bump Thrust

Takeoff bump thrust is available when increased thrust is needed for takeoff, above the normal maximum takeoff thrust setting. When selected using the FMC N1 LIMIT page, takeoff thrust is increased by either the flight crew or the autothrottle positioning the thrust levers to set N1 to the reference N1 bug.

Bump thrust is available for takeoff thrust, and is the applied thrust rating for Go-around thrust. Thrust bump is not applied to max continuous or climb thrust ratings.

EEC Alternate Mode

The EEC can operate in either of two alternate modes, soft or hard. If required signals are not available to operate in the normal mode, the EEC automatically changes to the soft alternate mode. When this occurs, the ALTN switch illuminates and the ON indication remains visible. In the soft alternate mode, the EEC uses the last valid flight conditions to define engine parameters which allows the mode change to occur with no immediate change in engine thrust. Thrust rating shortfalls or exceedances may occur as flight conditions change. The soft alternate mode remains until the hard alternate mode is entered by either retarding the thrust lever to idle or manually selecting ALTN with the EEC switch on the aft overhead panel.

Note: Loss of either DPC results in a loss of signal to both EECs. The EEC ALTN lights illuminate and each EEC reverts to the alternate mode to prevent the engines from operating on a single source of data.

When the hard alternate mode is entered, the EEC reverts to the alternate mode thrust schedule. Hard alternate mode thrust is always equal to or greater than normal mode thrust for the same lever position. If the hard alternate mode is entered by reducing the thrust lever to idle while in the soft alternate mode, the ALTN switch remains illuminated and the ON indication remains visible. When ALTN is selected manually, the ON indication is blanked.

The ALTERNATE MODE EEC schedule provides equal or greater thrust than the normal mode for the same lever position. Thrust protection is not provided in the ALTERNATE mode and maximum rated thrust is reached at a thrust lever position less than full forward.

Structural Limit Protection

The EEC provides N1 and N2 redline overspeed protection in both normal and alternate modes. The EGT limit must be observed by the crew because the EEC does not provide EGT redline exceedance protection.

If the EECs are in alternate mode, advancing the thrust levers full forward provides some overboost and should be considered only during emergency situations when all other available actions have been taken and terrain contact is imminent.

Thrust Control Malfunction Accommodation (TCMA)

Thrust Control Malfunction Accommodation is an EEC function that provides protection against idle thrust asymmetry conditions while on the ground (RTO or landing roll). The TCMA function does not compare thrust between the engines, each engine is monitored independently.

The EEC commands shutdown of the affected engine when the:

- airplane is on the ground, and
- thrust lever is at idle, and
- engine is above idle speed and not decelerating normally

The amber ENG FAIL alert illuminates when the engine is below idle (approximately 63%) and the engine start lever is in IDLE position.

Electronic Overspeed System (EOS)

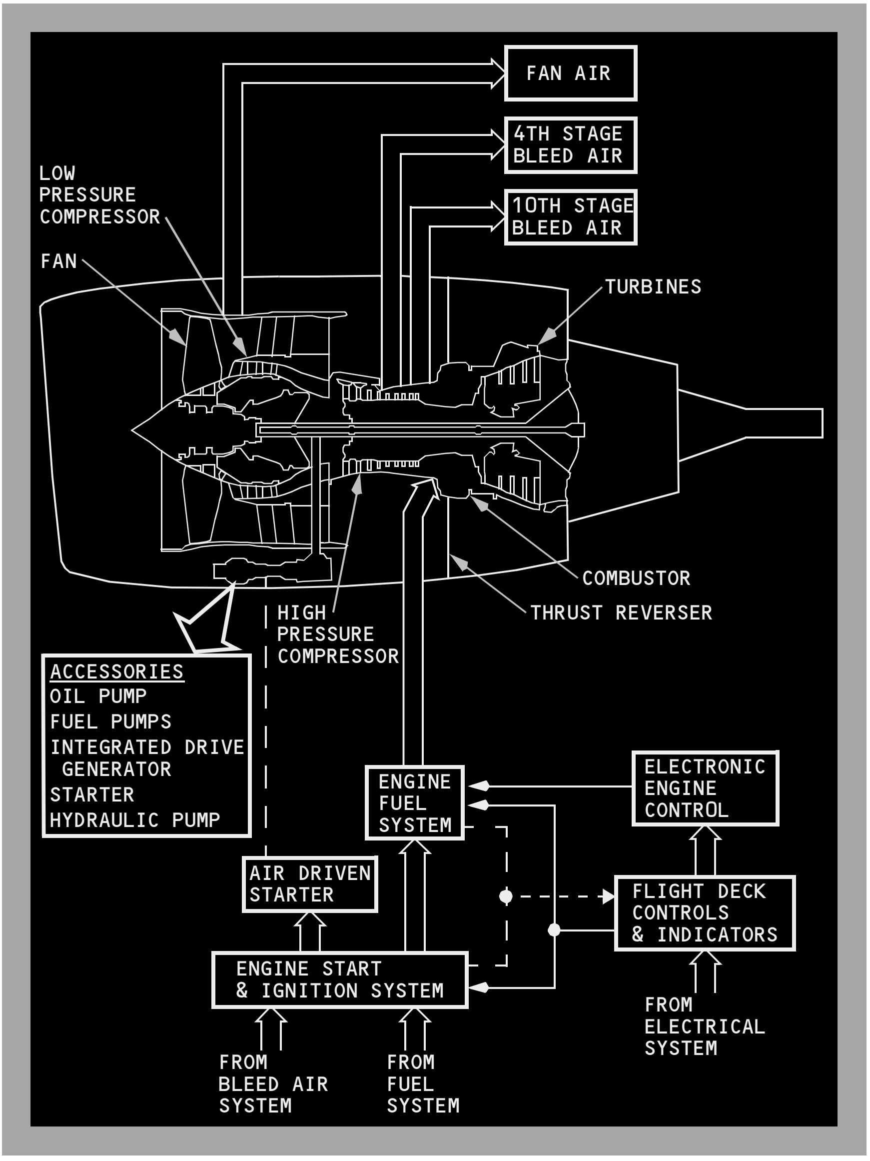
EOS is an EEC function that provides protection against the exceedance of engine structural design limits. If an uncontrollable N2 overspeed condition is detected the EEC automatically shuts off fuel to the affected engine. The amber ENG FAIL alert illuminates when N2 falls below 50%.

Idle Operation

The EEC automatically selects ground minimum idle, flight minimum idle, icing idle, and approach idle. Ground minimum idle is selected for ground operations and flight minimum idle is selected for most phases of flight. Icing idle is selected in flight if the flaps are up, the main gear is not down and locked and the engine anti-ice is on. When in icing mode, the EEC begins transition from minimum flight idle at 30,400 feet and increases idle in the descent to provide full icing idle at and below 22,000 feet. Approach idle is selected with flaps 15 or greater, or any time the flaps are not up and the engine anti-ice is on. For a given airspeed and altitude, N1 and N2% RPM will be higher for icing idle than approach idle. For the same conditions, approach idle is higher than flight minimum idle. Icing idle is required to meet the bleed demand of the engine anti ice system. Approach idle improves engine acceleration time in the event of a go–around. Approach idle is maintained until after touchdown, when ground minimum idle is selected. In flight, if a fault prevents the EEC from receiving flap or anti–ice signals, approach idle schedule begins below 19,000 feet MSL.

		Flap Setting		
		UP	Less than 15 Degrees	15 Degrees or Greater
Engine Anti-Ice	ON	Icing Idle	Approach Idle	Approach Idle
	OFF	Flight Idle	Flight Idle	Approach Idle

Power Plant Schematic



Engine Fuel System

Fuel is delivered under pressure from fuel pumps located in the fuel tanks. The fuel flows through a spar fuel shutoff valve located at the front wing spar. The fuel passes through the low pressure stage engine fuel pump where pressure is increased. It then passes through a fuel strainer, the main fuel/oil heat exchanger where engine oil heats the fuel, the high pressure stage fuel pump and a fuel filter which removes contaminants. Fuel automatically bypasses the filter if the filter becomes saturated. Before the fuel bypass occurs, the fuel FILTER BYPASS alert illuminates on the fuel control panel. Fuel then passes through the fuel metering unit (FMU), fuel flow transmitter and split control unit (SCU). To meet thrust requirements, the EEC meters fuel through the FMU.

The spar fuel shutoff valve and engine fuel shutoff valve in the FMU allow fuel flow to the engine when both valves are open. The valves are open when the engine fire switch is in and the start lever is in IDLE. Both valves close when either the start lever is in CUTOFF or the engine fire switch is out. SPAR VALVE CLOSED and ENG VALVE CLOSED lights located on the overhead panel indicate valve position.

Fuel flow is displayed on the display unit and is also provided to the flight management system (FMS).

Note: Fuel flow accuracy is reduced when engines are at idle which will affect the Fuel Used Readout.

Engine Oil System

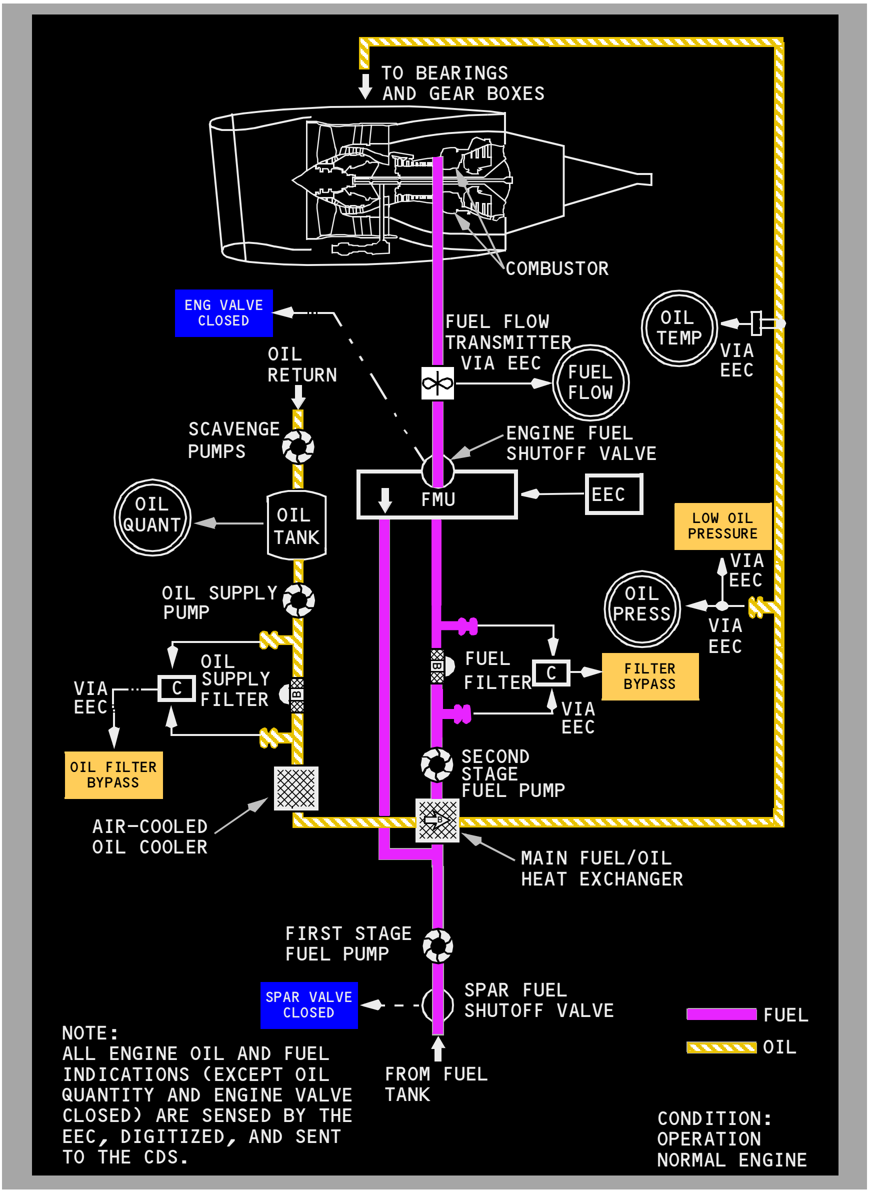
Oil from the individual engine tank is circulated under pressure, through the engine to lubricate the engine bearings and accessory gearbox. The oil quantity indicator, oil temperature indicator, oil pressure indicator and LOW OIL PRESSURE alert are all located on the display unit.

The oil system is pressurized by the engine driven oil pump. Oil from the pump goes through a filter element, servo fuel heater, air cooled oil cooler, and main oil /fuel heat exchanger to the engine bearings and gearbox. If the filter becomes saturated with contaminants, oil automatically bypasses the filter. Prior to the oil bypassing the filter, the OIL FILTER BYPASS alert illuminates on the Engine Display.

Temperature and pressure sensors provide signals to the EEC for oil temperature and pressure indications and the LOW OIL PRESSURE alert.

Engine driven scavenge pumps draw oil out of the gearbox and sumps and return it through the air/oil/debris separator to the oil tank.

Engine Fuel and Oil System Schematic



Engine Start System

Starter operation requires pressurized air and electrical power. Air from the bleed air system powers the starter motor. The APU, an external ground cart, or the other operating engine provides the bleed air.

In the GRD position, the engine start switch uses battery power to close the engine bleed air valve and open the start valve to allow pressure to rotate the starter. When the start valve opens, an amber START VALVE OPEN alert is provided on the MDS Engine Display. The starter rotates the N2 compressor through the accessory drive gear system. The EEC performs Bowed Rotor Motoring (BRM) after the Engine Start Switch has been moved to the GND position and before the Engine Start Lever is moved to IDLE. BRM straightens the N1 and N2 rotor shafts which will bow due to thermal buildup after the engine is shutdown. BRM is active for 6-90 seconds on the ground only. During BRM, MOTORING is displayed on the N2 gauge between 18% and 24% N2. When the engine accelerates to the recommended value (25% N2 or max motoring), moving the engine start lever to the IDLE position, the EEC performs a test of the TCMA and EOS functions. During this test, fuel flow will indicate zero and the engine fuel shutoff valve will open and close repeatedly. The ENG VALVE CLOSED light will illuminate and remain bright blue during this logic test, and will extinguish when the test is complete. Once the test is complete, the engine start sequence continues, the fuel valves on the wing spar and engine opens, and causes the EEC to supply fuel and ignition to the combustor where the fuel ignites.

At starter cutout speed (approximately 63% N2), power is removed from the start switch holding solenoid. The engine start switch returns to OFF, the engine bleed air valve returns to the selected position, and the start valve closes.

Abnormal Start Protection (Ground Starts Only)

During ground starts, the EEC monitors engine parameters to detect impending hot starts, engine stalls, EGT start limit exceedances, and wet starts. These protection features do not function during inflight starts.

If an impending hot start is detected by a rapid rise in EGT or EGT approaching the start limit, or a compressor stall occurs, the white box surrounding the EGT digital readout flashes white. The EEC turns off the ignition and shuts off fuel to the engine for an impending hot start or stall. The flashing white box resets when the start lever is moved to CUTOFF or the engine reaches idle N2.

If the EGT exceeds the starting limit, the EGT display, both box and dial, turn red. The EEC automatically turns off the ignition and shuts off fuel to the engine. The alert terminates and the display returns to white when EGT drops below the start limit. Following shutdown of both engines, the EGT box turns red to remind the crew of the exceedance.

A wet start occurs if the EGT does not rise after the start lever is moved to IDLE. If a wet start is detected, the EEC turns off the ignition and shuts off fuel to the engine 15 seconds after the start lever is moved to IDLE.

Engine Ignition System

Each engine has two igniter plugs. The EEC arms the igniter plug(s) selected by the ignition select switch. The left igniter plug receives power from the associated AC transfer bus. The right igniter plug receives power from the AC standby bus.

Auto-Relight

An auto-relight capability is provided for flameout protection. Whenever the EEC detects an engine flameout, both igniters are activated. A flameout is detected when an uncommanded rapid decrease in N2 occurs, or N2 is below idle RPM.

Inflight Starting

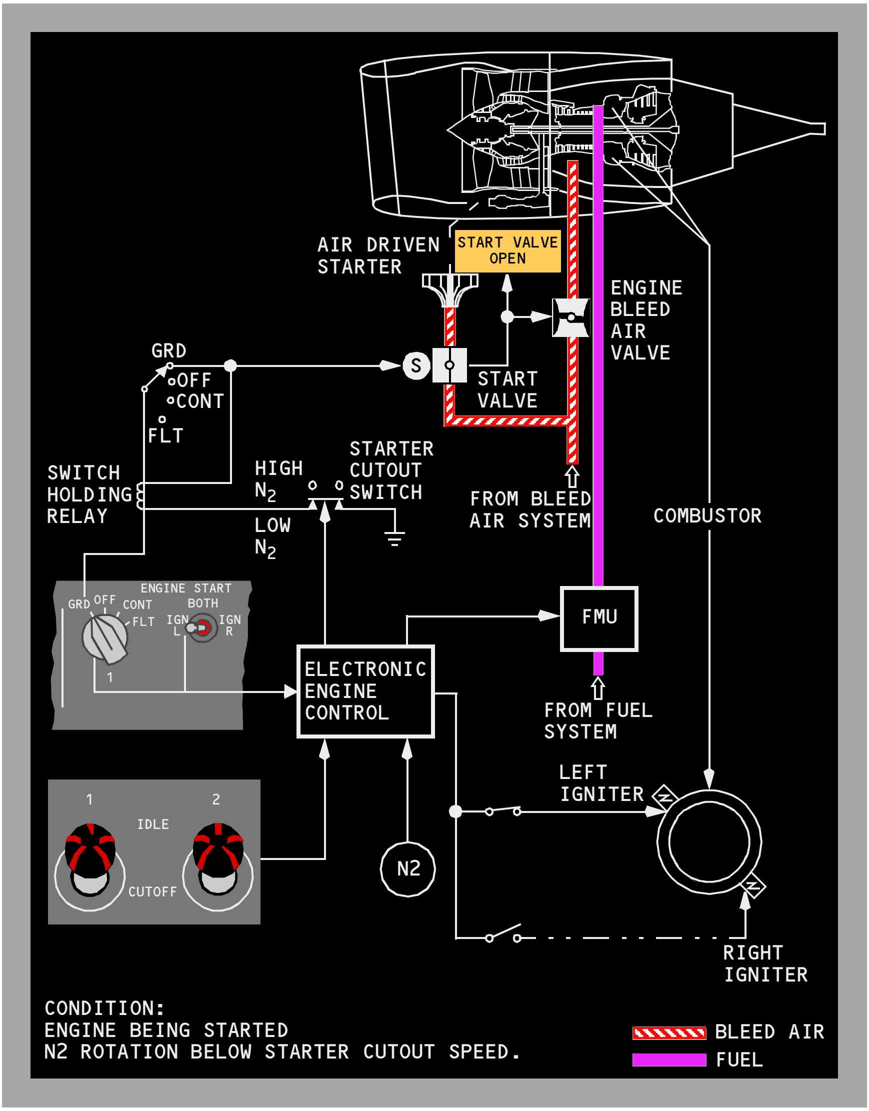
Two methods of starting an engine in flight are available, windmill and crossbleed. None of the ground start protection features are functional during inflight start.

Note: At low N2 values, the oil scavenge pump may not provide enough pressure to return oil to the tank, causing a low oil quantity indication. Normal oil quantity should be indicated after start.

If crossbleed starting is required, the X–BLD indication is displayed above the N2 dial. This indication is based on airplane altitude, airspeed and N2.

Note: During engine inflight starts if the EEC detects EGT to be within 10°C of the Start Limit Redline, the EEC momentarily interrupts fuel flow and ignition to the engine for approximately 1 second. After the interrupt, the EEC resumes fuel and ignition to continue the start attempt. The EEC repeats this fuel flow interruption until a successful start is achieved or the start attempt is aborted by the flight crew.

Engine Start and Ignition System Schematic



Thrust Reverser

Each engine is equipped with a hydraulically operated thrust reverser, consisting of left and right translating sleeves. Aft movement of the reverser sleeves causes blocker doors to deflect fan discharge air forward, through fixed cascade vanes, producing reverse thrust. The thrust reverser is for ground operations only and is used after touchdown to slow the airplane, reducing stopping distance and brake wear.

Hydraulic pressure for the operation of engine No. 1 and engine No. 2 thrust reversers comes from hydraulic systems A and B, respectively. If hydraulic system A and/or B fails, alternate operation for the affected thrust reverser is available through the standby hydraulic system. When the standby system is used, the affected thrust reverser deploys and retracts at a slower rate and some thrust asymmetry can be anticipated.

The thrust reverser can be deployed when either radio altimeter senses less than 10 feet altitude combined with an air/ground safety sensor in the ground mode. Movement of the reverse thrust levers is mechanically restricted until the forward thrust levers are in the idle position.

When reverse thrust is selected, an electro–mechanical lock releases, the isolation valve opens and the thrust reverser control valve moves to the deploy position, allowing hydraulic pressure to unlock and deploy the reverser system. An interlock mechanism restricts movement of the reverse thrust lever until the reverser sleeves have approached the deployed position. When either reverser sleeve moves from the stowed position, the amber REV indication, located on the Engine Display, illuminates. As the thrust reverser reaches the deployed position, the REV indication illuminates green and the reverse thrust lever can be raised to detent No. 2. This position provides adequate reverse thrust for normal operations. When necessary, the reverse thrust lever can be pulled beyond detent No. 2, providing maximum reverse thrust.

Downward motion of the reverse thrust lever past detent No. 1 (reverse idle thrust) initiates the command to stow the reverser. When the lever reaches the full down position, the control valve moves to the stow position allowing hydraulic pressure to stow and lock the reverser sleeves. After the thrust reverser is stowed, the isolation valve closes and the electro–mechanical lock engages.

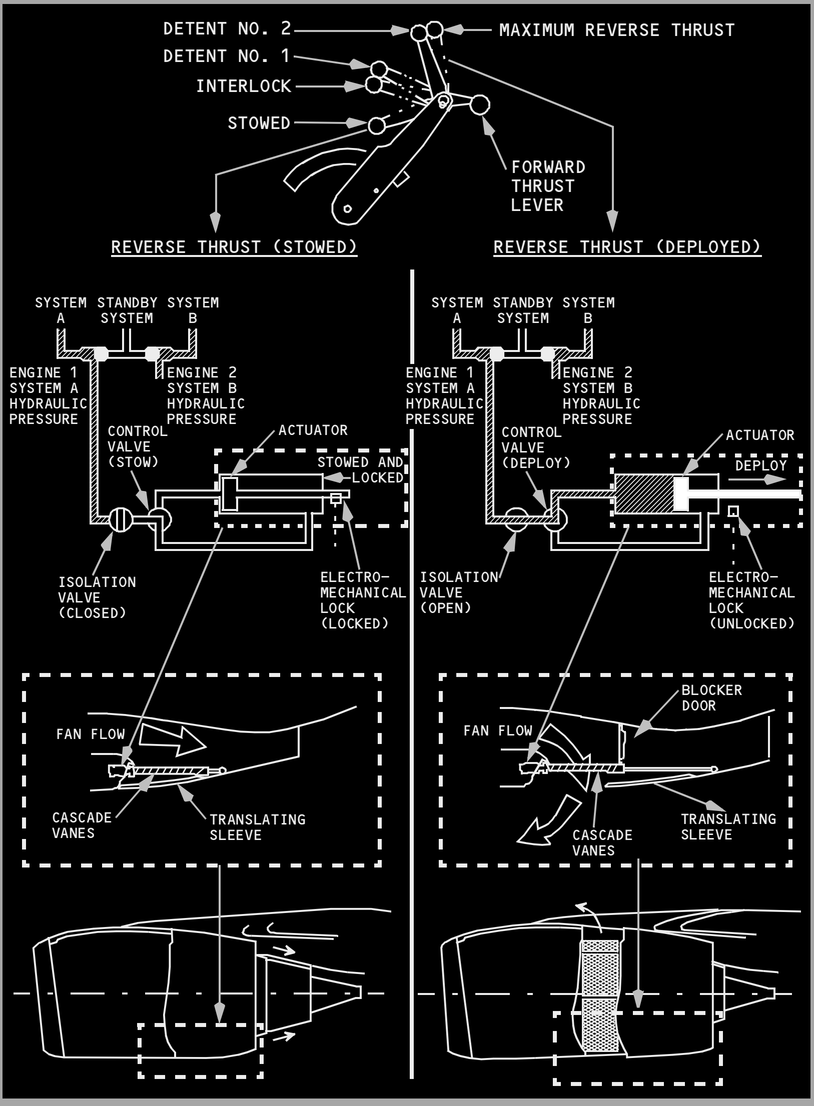
The REVERSER LIMITED light, located on the aft overhead panel, illuminates in-flight when a fault in the thrust reverser system limits reverser thrust. The thrust reverser will not deploy or reverse thrust will be limited to idle if commanded. The REVERSER LIMITED light illuminates on the ground when a malfunction has occurred. Any time the REVERSER LIMITED light illuminates, the MASTER CAUTION and ENG system annunciator lights illuminate.

Note: A pause in movement of the reverse thrust levers past detent No. 1 toward the stow position may cause MASTER CAUTION and ENG system annunciator lights to illuminate. A pause of approximately 8 seconds engages the electro-mechanical lock and prevents the thrust reverser sleeves from further movement. Cycling the thrust reversers may clear the fault and restore normal operation. The MAINT light illuminates 30 seconds after landing.

When the reverser sleeves are in the stow position, an electro–mechanical lock and two hydraulically operated locking actuators inhibit motion to each reverser sleeve until reverser extension is selected. In the event of incomplete stowage of the reverser sleeves toward the stowed position, the stow circuit maintains the isolation valve open and commands the control valve to the stow position directing hydraulic pressure to stow the reverser sleeves. The isolation valve remains open and the control valve is held in the stowed position until at least one locking actuator per sleeve is sensed locked, the thrust reverser is commanded to deploy or until corrective maintenance action is taken.

WARNING: Actuation of the thrust reversers on the ground without suitable precautions is dangerous to ground personnel.

Thrust Reverser Schematic

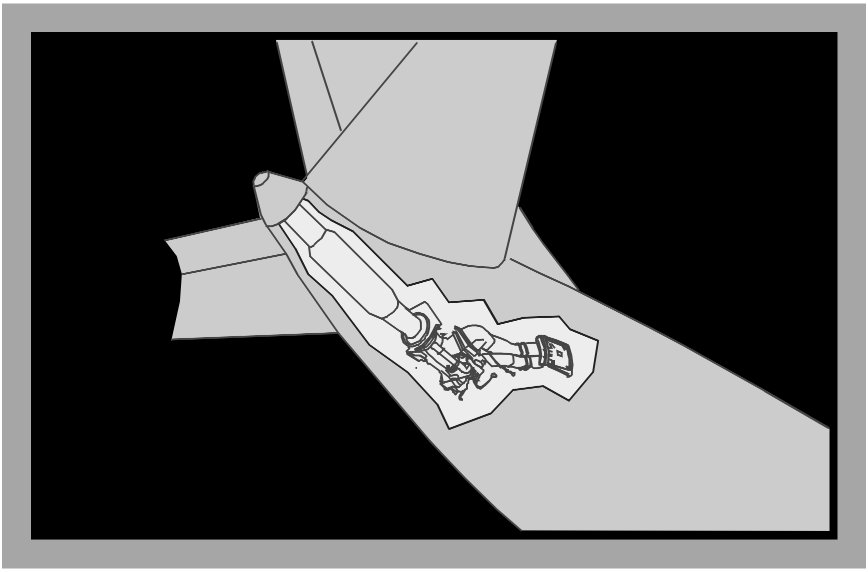


Introduction

The auxiliary power unit (APU) is a self–contained gas turbine engine installed within a fireproof compartment located in the tail of the airplane.

The APU supplies bleed air for engine starting or air conditioning. An AC electrical generator on the APU provides an auxiliary AC power source.

APU Location



APU Operation

The APU starts and operates up to the airplane maximum certified altitude.

The APU supplies bleed air for both air conditioning packs on the ground or one pack in flight. Both transfer buses can be powered on the ground or in flight.

APU Door

The APU air inlet door is located on the right side of the fuselage and is automatically operated. The APU air inlet door has 3 positions, closed, flight open (approximately 17 degrees) and ground open (approximately 45 degrees).

When the APU is operating:

- The APU door will automatically move from the ground position to the flight position at liftoff.
- The APU door will automatically move from the flight position to the ground position at touchdown.

APU Fuel Supply

Fuel to start and operate the APU comes from the left side of the fuel manifold when the AC fuel pumps are operating. If the AC fuel pumps are not operating, fuel is suction fed from the No. 1 tank. During APU operation, fuel is automatically heated to prevent icing.

APU Engine and Cooling Air

APU engine and cooling air routes to the APU through the air inlet door. The APU air inlet door has 3 positions, closed, flight open (approximately 17 degrees) and ground open (approximately 45 degrees). APU exhaust gases discharge overboard through an exhaust muffler.

The cooling air circulates through the APU compartment, passes through the oil cooler and vents through the exhaust outlet.

Electrical Requirements for APU Operation

APU operation requires the following:

- APU fire switch on the overheat/fire panel must be IN
- APU fire control handle on the APU ground control panel must be IN
- battery switch must be ON.

Electrical power to start the APU comes from No. 1 transfer bus or the airplane main battery. With AC power available, the starter generator uses AC power to start the APU. With no AC power, the starter generator uses battery power to start the APU.

Moving the battery switch to OFF on the ground or in the air automatically shuts down the APU because of power loss to the electronic control unit.

APU Start

The automatic start sequence begins by moving the APU switch momentarily to START. This initiates opening of the air inlet door. When the APU inlet door reaches the open position the start sequence begins. After the APU reaches the proper speed, ignition and fuel are provided. When the APU is ready to accept a bleed air or electrical load the APU GEN OFF BUS light illuminates.

Note: While the APU is starting using battery power only, the CPS FREQ indication will be blank and the AC VOLTS indication will be 0 when the AC Meters Selector is set to APU GEN. After the APU completes the start sequence and the blue APU GEN OFF BUS light illuminates, the CPS FREQ will show actual APU frequency and AC VOLTS will show actual APU voltage.

If the APU does not reach the proper speed with the proper acceleration rate within the time limit of the starter, the start cycle automatically terminates. The start cycle may take as long as 120 seconds. Automatic shutdown occurs in the event of EGT exceedance.

If the start fails or the APU GEN OFF BUS light fails to illuminate by the end of the start cycle, a system failure has occurred and the FAULT light illuminates.

Operate the APU for two full minutes before using it as a bleed air source. This two minutes stabilization is recommended to extend the service life of the APU.

APU Shutdown

Operate the APU for one full minute with no bleed air load prior to shutdown. This cooling period is recommended to extend the service life of the APU. When the APU switch is moved to OFF, this time delay is met automatically.

Moving the APU switch to OFF trips the APU generator, closes the APU bleed air valve and extinguishes the APU GEN OFF BUS light. Shutdown occurs automatically after 60 seconds. When the APU speed decreases sufficiently during shutdown, the fuel valve and inlet door close. If the fuel valve does not close, the FAULT light will illuminate after approximately 30 seconds. An immediate shutdown can be accomplished by pulling the APU fire switch.

Electronic Control Unit (ECU)

An electronic control unit (ECU) monitors and controls the APU. Automatic shutdown protection is provided for overspeed conditions, low oil pressure, high oil temperature, APU fire, fuel control unit failure, EGT exceedance, and other system faults monitored by the ECU.

The ECU automatically controls APU speed through the electronic fuel control. If speed or EGT exceed acceptable levels with the APU providing electrical load only, some electrical load is shed. When electrical load and air extraction raise the EGT above acceptable levels during engine starting, electrical load shedding occurs prior to reducing bleed air. When electrical load and air extraction raise the EGT above acceptable levels other than during engine starting, the inlet guide vanes move toward a closed position, reducing bleed air extraction while maintaining electrical load.

APU Automatic Load Shedding

In flight, if the APU is the only source of electrical power, all galley buses and main buses are automatically shed. If electrical load still exceeds design limits, both IFE buses are also automatically shed. On the ground, the APU attempts to carry a full electrical load. If an overload condition is sensed, the APU sheds galley buses and main buses until the load is within limits. Manual restoration of galley and main bus power can be attempted by moving the CAB/UTIL Power Switch to OFF, then back ON.

Fire Protection — Chapter 8
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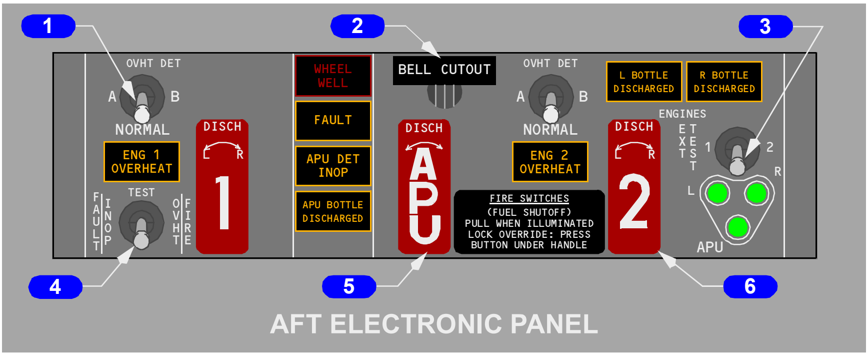
Overheat/Fire Protection Panel Switches



1 Overheat Detector (OVHT DET) Switch

NORMAL – detection loop A and loop B are active.

A – detection loop A is active.

B – detection loop B is active.

2 Fire Warning BELL CUTOUT Switch

Push –

- extinguishes both master FIRE WARN lights
- silences the fire warning bell
- silences the remote APU fire warning horn (on the ground only)
- resets the system for additional warnings.

3 Extinguisher (EXT) TEST Switch

(spring–loaded to center)

1 or 2 – tests bottle discharge circuit continuity for all three extinguisher bottles.

4 Fault/Inoperative (FAULT/INOP) and Overheat/Fire (OVHT/FIRE) TEST Switch

(spring–loaded to center)

FAULT/INOP – tests fault detection circuits for both engines and the APU.

OVHT/FIRE – tests overheat and fire detection loops on both engines and APU, and wheel well fire detector

Note: See Fire and Overheat Detection System Fault Test in Section 20.

5 APU Fire Switch

Illuminated (red) –

- indicates fire in APU
- unlocks APU fire switch.

Note: Master FIRE WARN lights illuminate, fire warning bell sounds, and in the main wheel well the APU fire warning horn sounds (on ground only), and APU fire warning light flashes.

In – normal position, mechanically locked if no fire signal.

Up –

- arms APU extinguisher circuit
- closes fuel shutoff valve, APU bleed air valve, and APU inlet door
- trips generator control relay and breaker
- allows APU fire switch to rotate.

Rotate (left or right) –

- discharges APU fire bottle.

6 Engine Fire Switch

Illuminated (red) –

- indicates fire in related engine
- unlocks related engine fire switch.

Note: Master FIRE WARN lights illuminate and fire warning bell sounds.

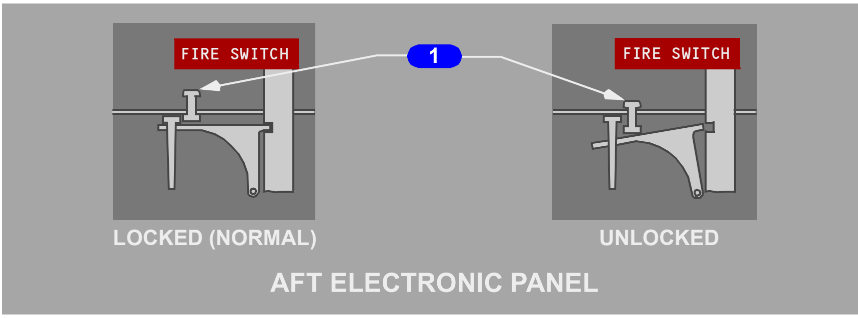
In – normal position, mechanically locked if no fire signal.

Up –

- arms one discharge squib on each engine fire extinguisher
- closes fuel, hydraulic shutoff and engine bleed air valves
- disables thrust reverser
- trips generator control relay and breaker
- deactivates engine driven hydraulic pump LOW PRESSURE light
- allows engine fire switch to rotate.

Rotate (left or right) – discharges related fire bottle.

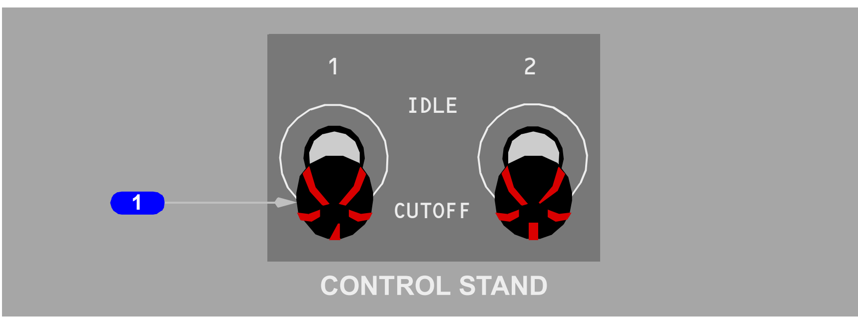
Fire Switch Override



1 Fire Switch Override

Push – unlocks fire switch.

Engine Start Levers



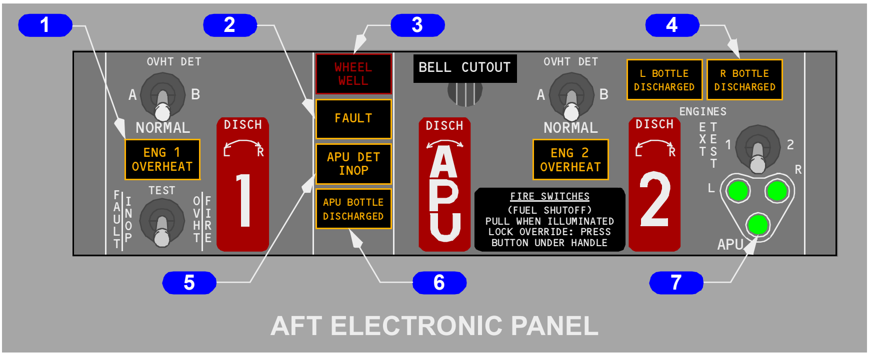
1 Engine Start Levers

Illuminated (red) –

- an associated engine fire is detected, or
- the fire TEST switch is held to the OVHT/FIRE position.

CAUTION: Do not apply rotational force when moving the engine start lever.

Overheat/Fire Protection Panel Lights



1 Engine (ENG) OVERHEAT Light

Illuminated (amber) – indicates overheat in related engine.

Note: MASTER CAUTION and OVHT/DET system annunciator lights illuminate.

2 FAULT Light

Illuminated (amber) – with the overheat detector switch in NORMAL - indicates both detector loops for an engine have failed.

Illuminated (amber) – with the overheat detector switch in A or B – indicates the selected loop for an engine has failed.

Note: MASTER CAUTION and OVHT/DET system annunciator lights do not illuminate.

3 WHEEL WELL Fire Warning Light

Illuminated (red) – indicates fire in main gear wheel well

Note: Master FIRE WARN lights illuminate and fire warning bell sounds.

4 Engine BOTTLE DISCHARGED Light

Illuminated (amber) – indicates related fire extinguisher bottle has discharged.

5 APU Detector Inoperative (DET INOP) Light

Illuminated (amber) – indicates APU detector loop has failed.

Note: MASTER CAUTION and OVHT/DET system annunciator lights illuminate.

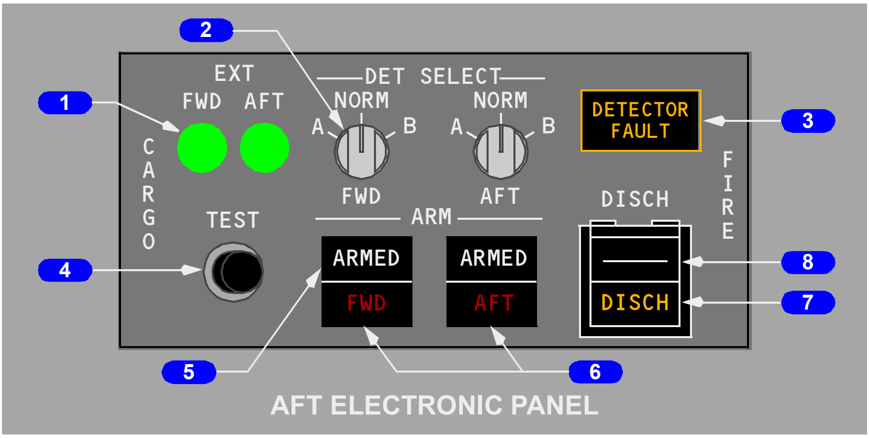
6 APU BOTTLE DISCHARGED Light

Illuminated (amber) – indicates APU extinguisher bottle has discharged.

7 Extinguisher Test (EXT TEST) Lights

Illuminated (green) – EXT TEST switch is positioned to 1 or 2 and circuit continuity is normal.

Cargo Fire Panel



1 Extinguisher (EXT) Test Lights

Illuminated (green) - Cargo Fire TEST switch is pushed and fire bottle discharge squib circuit continuity is normal.

2 Detector Select (DET SELECT) Switches

NORM - detection loop A and B are active.

A - detection loop A is active.

B - detection loop B is active.

3 DETECTOR FAULT Light

Illuminated (amber) -

- One or more of the selected detector loop(s) in either cargo compartment has failed.

4 Cargo Fire TEST Switch

PUSH - tests circuits for both forward and aft cargo fire detector loops and suppression system.

Note: See Cargo Fire System Tests in Section 20.

5 Cargo Fire ARM Switches

PUSH -

- FWD ARMED - extinguisher armed for the forward cargo compartment
- AFT ARMED - extinguisher armed for the aft cargo compartment.

Note: If the first bottle has discharged and the system remains armed, the second bottle discharge is inhibited upon landing. The second bottle discharge timer is disabled when the system is disarmed.

6 Cargo Fire (FWD/AFT) Warning Lights

Illuminated (red) -

- at least one detector in each loop detects smoke
- with power failed in one loop, at least one detector on the remaining loop detects smoke.

Note: Master FIRE WARN lights illuminate and fire warning bell sounds.

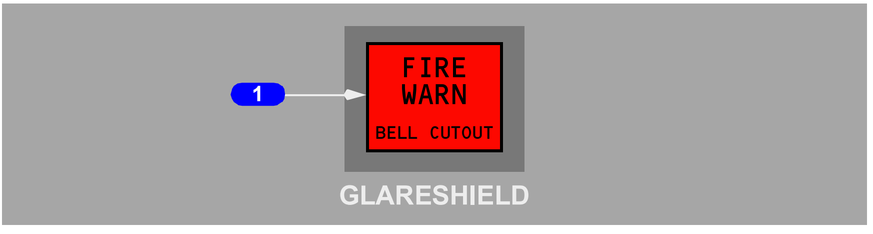
7 Cargo Fire Bottle Discharge (DISCH) Light

Illuminated (amber) - indicates that either extinguisher bottle has discharged

8 Cargo Fire Discharge (DISCH) Switch

PUSH - if system is armed, discharges the first extinguisher bottle. The timer is set for 15 minutes to discharge the second extinguisher bottle.

Master Fire Warning Light



1 Master Fire Warning (FIRE WARN) Lights

Illuminated (red) – indicates a fire warning (or system test) in engine, APU, main gear wheel well or cargo compartment

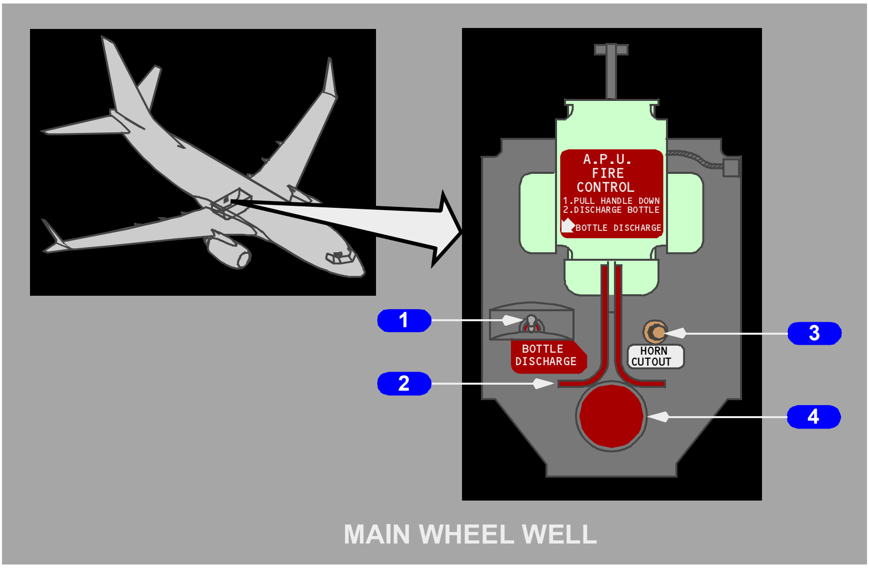
- fire warning bell sounds
- if on ground, remote APU fire warning horn sounds.

Push –

- extinguishes both master FIRE WARN lights
- silences fire warning bell
- silences remote APU fire warning horn
- resets system for additional warnings.

Note: Pushing fire warning bell cutout switch on overheat/fire protection panel results in same actions.

APU Ground Control Panel



1 APU BOTTLE DISCHARGE Switch

(spring–loaded to the right and safety wired.)

Left – discharges APU extinguisher.

Note: Armed only if APU fire control handle is pulled at this panel.

2 APU Fire Control Handle

Up – normal position.

Down –

- arms APU BOTTLE DISCHARGE switch (on this panel only)
- closes APU fuel shutoff, bleed air valve and APU inlet door
- trips generator control relay and breaker.

3 APU Fire Warning HORN CUTOUT Switch

Push –

- silences fire alarm bell
- silences APU fire warning horn
- causes APU fire warning light to stop flashing but remain illuminated.

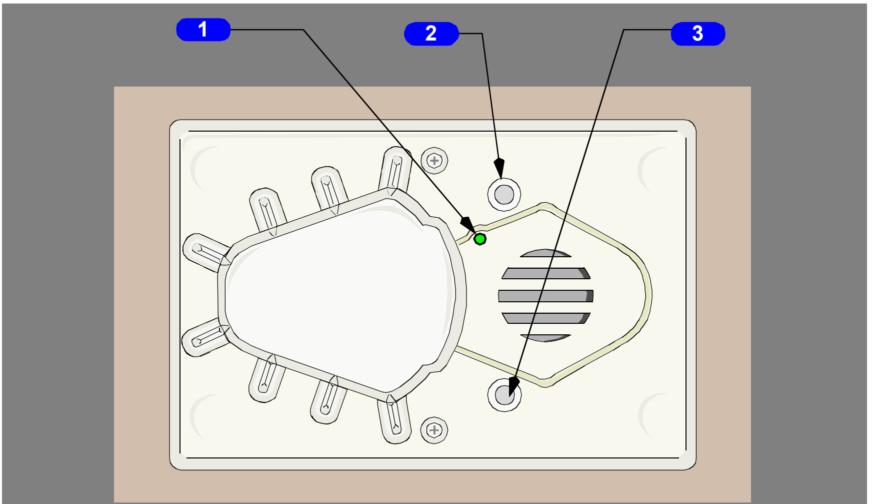
4 APU Fire Warning Light

Illuminated (red flashing) – indicates fire in APU.

Note: Also, flight deck fire warning bell sounds and APU fire warning horn in main wheel well sounds.

Illuminated (red steady) – indicates APU fire warning HORN CUTOUT switch has been pushed following an APU fire indication.

Lavatory Fire
Lavatory Smoke Detection



Photoelectric Smoke Detector
(Typical)

1 Status Indicator Light

Illuminated (green) -

- steady - smoke detector has power and is operating properly
- blinking - maintenance is required

Illuminated (red) -

- steady - smoke has been detected
- blinking - detector has failed

2 Self-Test Switch

Push -

- alarm horn sounds
- Status Indicator Light illuminates red
- external horn sounds

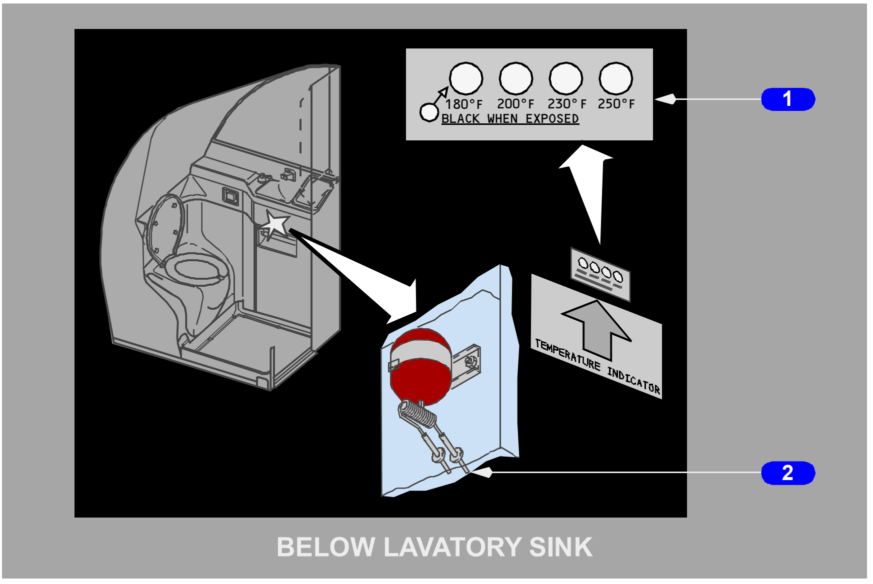
3 Horn Cancel Switch

Push -

- alarm horn is silenced

Note: When the Cancel switch is released and smoke is not sensed for 30 seconds, the smoke detector is automatically reset.

Lavatory Fire Extinguisher



1 TEMPERATURE INDICATOR Placard

White – normal condition.

Black – exposed to high temperatures.

2 Heat Activated Nozzles

Flat black – normal condition.

Aluminum – indicates extinguisher has discharged.

Both nozzles discharge toward the towel disposal container.

Fire Protection — Chapter 8
System Description — Section 20

Introduction

There are fire detection and extinguishing systems for:

- engines
- APU
- lavatories

The engines also have overheat detection systems.

The main gear wheel well has a fire detection system, but no fire extinguishing system.

The cargo compartment has smoke detection and fire suppression systems.

Engine Fire Protection

Engine fire protection consists of these systems:

- engine overheat and fire detection powered by the battery bus
- engine fire extinguishing powered by the hot battery bus.

Engine Overheat and Fire Detection

Each engine contains two overheat/fire detector loops. Each loop provides both fire and overheat detection. As the temperature of a detector increases to a predetermined limit, the detector senses an overheat condition. At higher temperatures, the detector senses a fire condition. Normally, both detector loops must sense a fire or overheat condition to cause an engine overheat or fire alert. The ENG OVERHEAT light or engine fire switch remains illuminated until the temperature drops below the onset temperature.

An OVHT DET switch for each engine, labeled A, B, and NORMAL, permits selection of either loop A or B, or both A and B, as the active detecting loops.

The system contains a fault monitoring circuit. If one loop fails with the OVHT DET switch in NORMAL, that loop is automatically deselected and the remaining loop functions as a single loop detector. There is no flight deck indication of single loop failure. If both loops fail on an engine, the FAULT light illuminates and the system is inoperative.

If the OVHT DET switch is positioned to A or B, the system operates as a single loop system. The non–selected loop is not monitored. If the selected loop fails, the FAULT light illuminates and the system is inoperative.

The indications of an engine overheat are:

- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- the related ENG OVERHEAT light illuminates.

The indications of an engine fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the related engine fire switch illuminates
- the related engine start lever illuminates
- all related engine overheat alert indications illuminate.

Engine Fire Extinguishing

The engine fire extinguisher system consists of two engine fire extinguisher bottles, two engine fire switches, two BOTTLE DISCHARGED lights, and an EXT TEST switch. Either or both bottles can be discharged into either engine.

The engine fire switches are normally locked down to prevent inadvertent shutdown of an engine. Illumination of an engine fire switch or ENG OVERHEAT light unlocks the engine fire switch. The switches may also be unlocked manually.

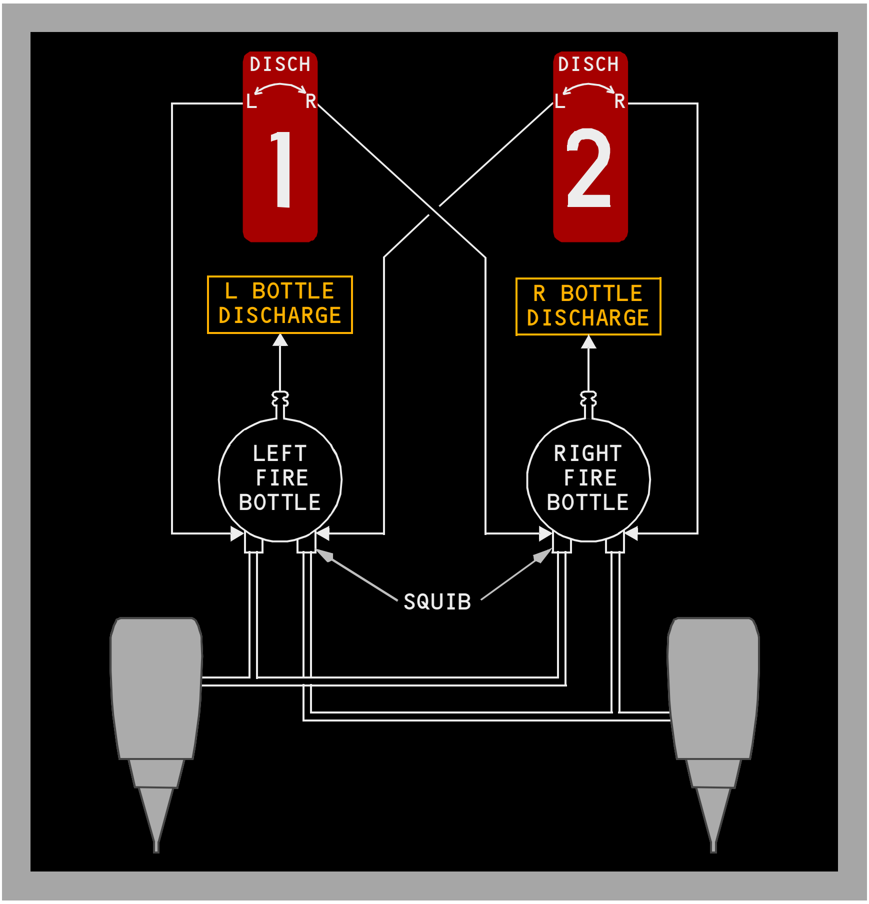
Pulling the engine fire switch up:

- closes both the engine fuel shutoff valve and the spar fuel shutoff valve
- closes the engine bleed air valve resulting in loss of wing anti–ice to the affected wing and closure of bleed air operated pack valve
- trips the generator control relay and breaker
- closes the hydraulic fluid shutoff valve. The engine driven hydraulic pump LOW PRESSURE light is deactivated
- disables thrust reverser for the related engine.
- allows the engine fire switch to be rotated for discharge
- arms one discharge squib on each engine fire extinguisher bottle.

Rotating the engine fire switch electrically “fires” a squib, discharging the extinguishing agent into the related engine. Rotating the switch the other way discharges the remaining bottle.

The L or R BOTTLE DISCHARGED light illuminates a few seconds after the engine fire switch is rotated, indicating the bottle has discharged.

Engine Fire Extinguisher Schematic



APU Fire Protection

APU fire protection consists of these systems:

- APU fire detection powered by the battery bus.
- APU fire extinguishing powered by the hot battery bus.

APU Fire Detection

A single fire detection loop is installed on the APU. As the temperature of the detector increases to a predetermined limit, the detector senses a fire condition. The APU fire switch remains illuminated until the temperature of the detector has decreased below the onset temperature.

The system contains a fault monitoring circuit. If the loop fails, the APU DET INOP light illuminates indicating the APU fire detection system is inoperative.

The indications of an APU fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the APU fire switch illuminates
- the APU automatically shuts down
- the wheel well APU fire warning horn sounds, (on the ground only), and the wheel well APU fire warning light flashes.

APU Fire Extinguishing

The APU fire extinguisher system consists of one APU fire extinguisher bottle, an APU fire switch, an APU BOTTLE DISCHARGED light, and an EXT TEST switch. The APU ground control panel located in the right main wheel well also contains an APU fire warning light, an APU BOTTLE DISCHARGE switch, an APU fire control handle and APU HORN CUTOUT switch.

The APU fire switch is normally locked down to prevent inadvertent shutdown of the APU. Illumination of the APU fire switch unlocks the switch. The switch may also be unlocked manually.

Pulling the APU Fire switch up:

- provides backup for the automatic shutdown feature
- deactivates the fuel solenoid and closes the APU fuel shutoff valve
- closes the APU bleed air valve
- closes the APU air inlet door
- trips the APU generator control relay and breaker
- allows the APU fire switch to be rotated for discharge
- arms the APU fire extinguisher bottle squib.

Rotating the APU fire switch in either direction electrically “fires” the squib discharging the extinguishing agent into the APU. The APU BOTTLE DISCHARGED light illuminates after a few seconds, indicating the bottle has discharged.

Main Wheel Well Fire Protection

Main wheel well fire protection consists of fire detection powered by AC transfer bus 2 and battery bus.

Note: The main wheel well has no fire extinguishing system. The nose wheel well does not have a fire detection system.

Main Wheel Well Fire Detection

A dual fire detector loop is installed in the main wheel well. As the temperature of the detector increases to a predetermined limit, the detector senses a fire condition. The WHEEL WELL fire warning light remains illuminated until the temperature of the detector has decreased below the onset temperature.

The indications for a main wheel well fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the WHEEL WELL fire warning light illuminates.

Cargo Compartment Fire Protection

Cargo fire protection consists of these systems:

- cargo compartment smoke detection powered by DC bus 1 and DC bus 2
- cargo compartment fire suppression powered by the hot battery bus.

Cargo Compartment Smoke Detection

The forward and aft cargo compartments each have smoke detectors in a dual loop configuration. Normally, both detection loops must sense smoke to cause an alert. In the event of a detector failure, the system can be manually converted to single-loop detection through the DETECT SELECT switch on the cargo fire control panel. In the event of a power failure in one loop the system automatically converts to single-loop detection.

Cargo Compartment Fire Warning

The indications of a cargo compartment fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the FWD/AFT cargo fire warning light(s) illuminates.

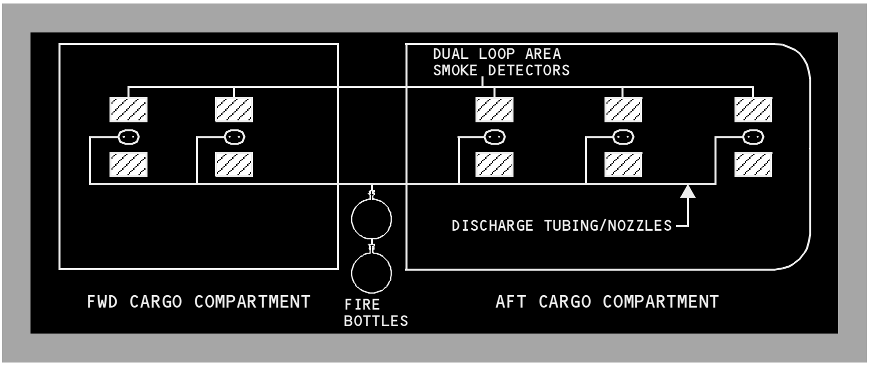
After the initial indication of a cargo compartment fire, the FWD/AFT cargo fire warning light(s) can extinguish, remain illuminated, or re-illuminate over the remainder of the flight. If the FWD/AFT cargo fire warning light(s) re-illuminate, both master FIRE WARN lights also re-illuminate and the fire warning bell sounds.

Cargo Compartment Fire Suppression

The Cargo Compartment Fire Suppression system provides fire suppression to the forward and aft cargo compartments using a shared system of fire suppressing chemical agent. Either the forward or aft cargo compartment can be selected for discharge of the fire-suppression agent. Compartment selection is made by pushing the appropriate cargo fire ARMED switch, which arms the discharge port for the selected compartment. Once armed, the system is activated by pushing the cargo fire DISCH switch. The cargo fire DISCH light illuminates once the bottle contents are discharged. It may take up to 30 seconds for the light to illuminate. The system suppresses fire, and might not be capable of completely extinguishing a fire. Smoke can remain or continue to be generated within the cargo compartment until the fire is extinguished by firefighting personnel upon landing. The optical sensors of the Cargo Fire Detection System cannot distinguish between smoke particles and the fire suppression agent. The cargo compartment fire warning lights may remain illuminated or re-illuminate after discharge of the fire suppression bottles.

Two Halon-filled fire-suppression bottles are installed: one 25 lb High-Rate Discharge (HRD) bottle and one 33 lb Low-Rate Discharge (LRD) bottle. After the appropriate cargo fire ARMED switch is pushed, pushing the cargo fire DISCH switch completely discharges the HRD bottle contents into the selected cargo compartment and starts a 15 minute timer. After 15 minutes, the LRD bottle discharges its contents at a reduced metered flow into the selected compartment. This provides 195 minutes of fire suppression, supporting a 180 minute flight and a 15 minute reserve. Discharge of the LRD bottle may be disabled if the system is disarmed. Upon landing, if the HRD bottle was discharged and the system remains armed, the LRD bottle discharge is inhibited.

Cargo Fire-Suppression System Schematic



Lavatory Fire Protection

Lavatory fire protection consists of these systems:

- lavatory smoke detection
- lavatory fire extinguishing (heat activated).

Lavatory Smoke Detection

The lavatory smoke detection system monitors for the presence of smoke. When smoke is detected:

- an aural warning sounds
- the red status indicator light on the lavatory smoke detector panel illuminates.
- there is no flight deck indication. The alarm is manually silenced at the activated detector, and the system will reset automatically when no smoke has been detected for 30 seconds.

Lavatory Fire Extinguisher System

A fire extinguisher system is located beneath the sink area in each lavatory. When a fire is detected:

- fire extinguisher operation is automatic
- flight deck has no indication of extinguisher discharge.

Fire and Overheat System Tests

The fire and overheat detection systems can be tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch. Extinguisher continuity can be tested by pushing and holding the EXT TEST switch. All test indications clear when switches are released.

FAULT/INOP Test Detection

The fault detection circuits for both the engines and the APU are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the FAULT/INOP position.

The indications for the FAULT/INOP test are:

- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- the FAULT light illuminates
- the APU DET INOP light illuminates.

OVERHEAT/FIRE Test Detection

The overheat and fire detection loops on both engines, the APU, and the fire detector in the wheel well are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the OVHT/FIRE position.

The indications for the OVHT/FIRE test are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- both engine fire switches illuminate
- both engine start levers illuminate
- the APU fire switch illuminates
- both ENG OVERHEAT lights illuminate
- the WHEEL WELL fire warning light illuminates if AC power is available
- on the ground, the wheel well APU fire warning horn sounds and the wheel well APU fire warning light flashes.

Extinguisher Test

When the EXT TEST switch is positioned to 1 or 2, the green EXT TEST lights illuminate, verifying circuit continuity from the squib to the engine and APU fire switch.

Cargo Fire System Tests

The cargo fire detection and suppression system can be tested by pushing and holding the cargo fire TEST switch. This sends a test signal to the forward and aft cargo fire detector loops and verifies continuity of the extinguisher bottle squib circuits. All test indications clear when the TEST switch is released

Cargo Fire TEST

The indications for the Cargo Fire test are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the extinguisher test lights illuminate
- the FWD and AFT cargo fire warning lights illuminate when all detectors in selected loops (s) respond to the fire test
- the cargo fire bottle DISCH light illuminates

Note: The fire warning BELL CUTOUT switch on the Overheat/Fire Protection panel can silence the fire warning bell and extinguish the master FIRE WARN lights

Note: During a Cargo Fire Test, the DETECTOR Fault light will illuminate if one or more detectors in the loop(s) has failed.

Note: Individual detector faults can only be detected by a manually initiated test. The MASTER CAUTION light does not illuminate.

Note: At the end of cargo fire testing, up to a four second delay may occur to allow all applicable indications to extinguish at the same time.

Cargo Fire Extinguisher Test

When the Cargo Fire TEST button is pushed, the green EXT lights illuminate, verifying the fire bottle discharge squib circuit continuity is normal.

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Flight Controls — Chapter 9

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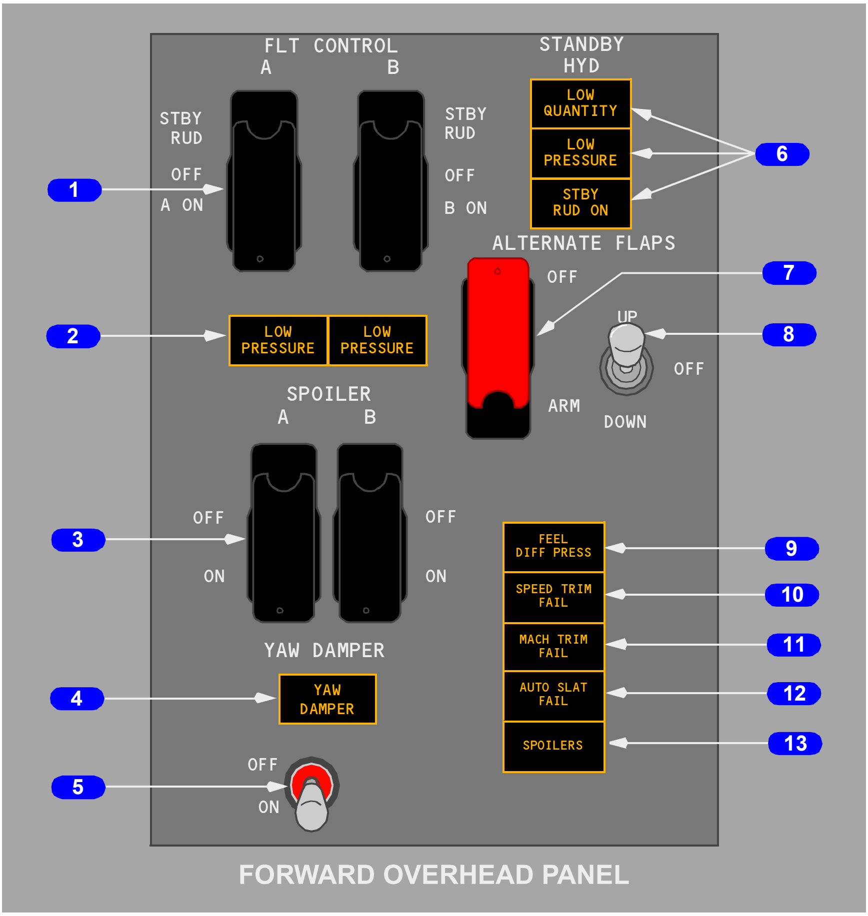
Flight Control Panel



1 FLIGHT CONTROL Switches

STBY RUD - activates standby hydraulic system pump and opens standby rudder shutoff valve to pressurize standby rudder power control unit.

OFF - closes flight control shutoff valve isolating ailerons, elevators and rudder from associated hydraulic system pressure.

ON (guarded position) - normal operating position.

2 Flight Control LOW PRESSURE Lights

Illuminated (amber) -

- indicates low hydraulic system (A or B) pressure to ailerons, elevator and rudder
- deactivated when associated FLIGHT CONTROL switch is positioned to STBY RUD and standby rudder shutoff valve opens.

3 Flight SPOILER Switches

ON (guarded position) – normal operating position.

OFF – closes the respective flight spoiler shutoff valve.

Note: Used for maintenance purposes only.

4 YAW DAMPER Light

Illuminated (amber) – yaw damper is not engaged.

5 YAW DAMPER Switch

OFF – disengages yaw damper.

ON –

- engages main yaw damper to main rudder power control unit if the B FLT CONTROL switch is in the ON position
- engages standby yaw damper to standby rudder power control unit if both the A and B FLT CONTROL switches are in the STBY RUD position.

6 STANDBY HYD Lights

STANDBY HYDRAULIC LOW QUANTITY Light

Illuminated (amber) -

- indicates low quantity in standby hydraulic reservoir
- always armed.

STANDBY HYDRAULIC LOW PRESSURE Light

Illuminated (amber) -

- indicates output pressure of standby pump is low
- armed only when standby pump operation has been selected or automatic standby function is activated.

STBY RUD ON Light

- Illuminated (amber) - indicates the standby rudder system is commanded on to pressurize the standby rudder power control unit.

7 ALTERNATE FLAPS Master Switch

OFF (guarded position) – normal operating position.

ARM – closes TE flap bypass valve, activates standby pump, and arms the ALTERNATE FLAPS position switch.

8 ALTERNATE FLAPS Position Switch

Functions only when the ALTERNATE FLAPS master switch is in ARM.

UP –

- electrically retracts TE flaps
- LE devices remain extended and cannot be retracted by the alternate flaps system.

OFF – normal operating position.

DOWN (spring loaded to OFF) –

- (momentary) fully extends LE devices using standby hydraulic pressure
- (hold) electrically extends TE flaps until released.

9 Feel Differential Pressure (FEEL DIFF PRESS) Light

Armed when the TE flaps are up or down.

Illuminated (amber) -

- indicates excessive differential pressure in the elevator feel computer

Note: Excessive differential pressure can be caused by erroneous activation of the Elevator Feel Shift module.

10 Speed Trim Failure (SPEED TRIM FAIL) Light

Illuminated (amber) –

- indicates failure of the Speed Trim System (Speed Trim function or MCAS function). If one function fails, the other function is inhibited.
- indicates failure of a single FCC channel when MASTER CAUTION recall is activated and light extinguishes when Master Caution System is reset.

11 Mach Trim Failure (MACH TRIM FAIL) Light

Illuminated (amber) –

- indicates failure of the mach trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when master caution system is reset.

12 Automatic Slat Failure (AUTO SLAT FAIL) Light

Illuminated (amber) –

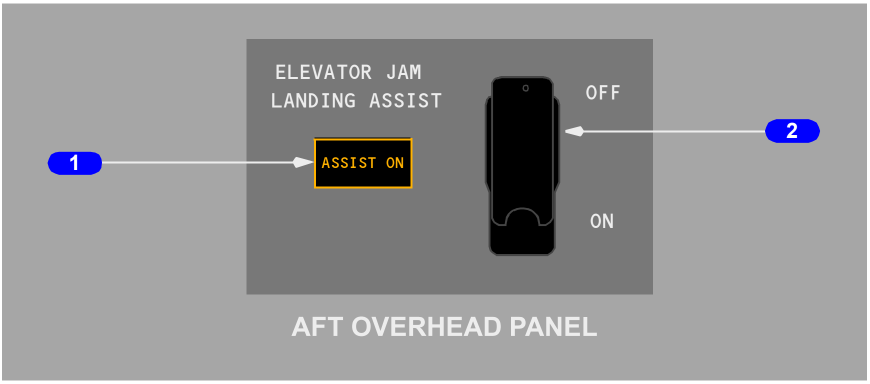
- indicates failure of the auto slat system
- indicates failure of a single Stall Management/Yaw Damper (SMYD) computer when illuminated during MASTER CAUTION recall and extinguishes when master caution system is reset.

13 SPOILERS Light

Illuminated (amber) –

- activated by signal from spoiler control electronics unit
- indicates spoiler system fault.

Elevator Jam Landing Assist Panel



1 ASSIST ON Light

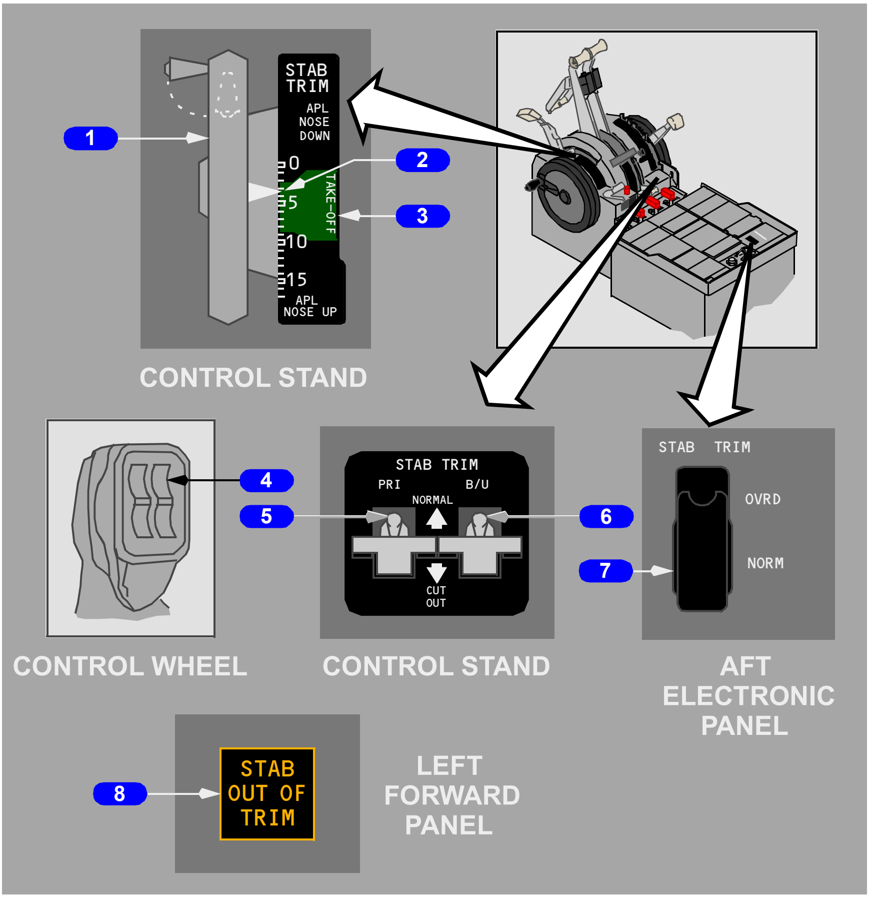
Illuminated (amber) - indicates the Elevator Jam Landing Assist function is activated.

2 Elevator Jam Landing Assist Switch

OFF (guarded position) – normal operating position.

ON – Activates Elevator Jam Landing Assist function when flaps are 1 or greater and the autopilot is disengaged.

Stabilizer



1 Stabilizer Trim Wheel

- provides for manual operation of stabilizer
- overrides any other stabilizer trim inputs
- rotates when stabilizer is in motion.

Note: Handle should be folded inside stabilizer trim wheel for normal operation

2 Stabilizer Trim Indicator

Indicates units of airplane trim on the adjacent scale.

3 Stabilizer Trim Green Band Range

Corresponds to allowable range of trim settings for takeoff.

4 Main Electric Stabilizer Trim Switches (spring-loaded to neutral)

Push (both) –

- electrically commands stabilizer trim in desired direction
- autopilot disengages if engaged
- overrides Speed Trim System (Speed Trim function and MCAS function) if active.

5 Stabilizer Trim PRI (primary) Cutout switch

NORMAL – normal operating position

CUTOUT – stops stabilizer trim inputs from main electric, autopilot and Speed Trim System (Speed Trim function and MCAS function).

6 Stabilizer Trim B/U (backup) Cutout switch

NORMAL – normal operating position.

CUTOUT – stops stabilizer trim inputs from main electric, autopilot and Speed Trim System (Speed Trim function and MCAS function).

7 Stabilizer Trim Override Switch

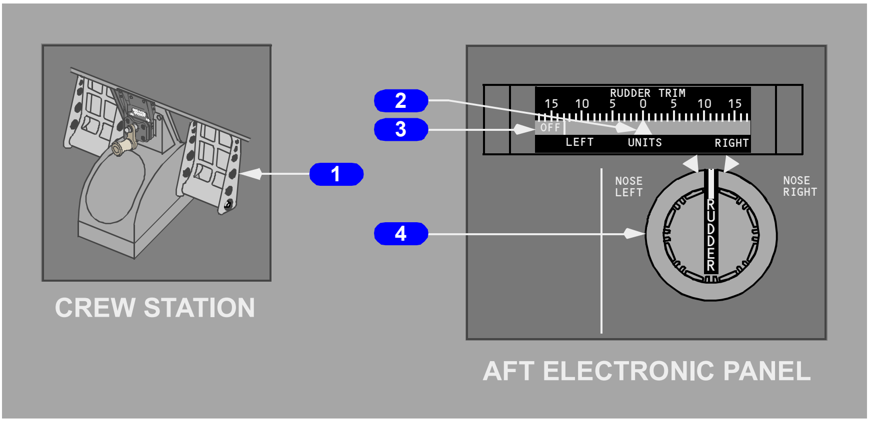
OVRD – bypasses the control column actuated stabilizer trim cutout switches to restore power to the Stabilizer Trim Switches

NORM (guarded position) – normal operating position.

8 Stabilizer Out of Trim (STAB OUT OF TRIM) Light

Refer to Chapter 4 – Automatic Flight

Rudder



1 Rudder Pedals

Push –

- controls rudder position
- permits nose gear steering up to 6 degrees each side of center.

2 Rudder Trim Indicator

Indicates units of rudder trim.

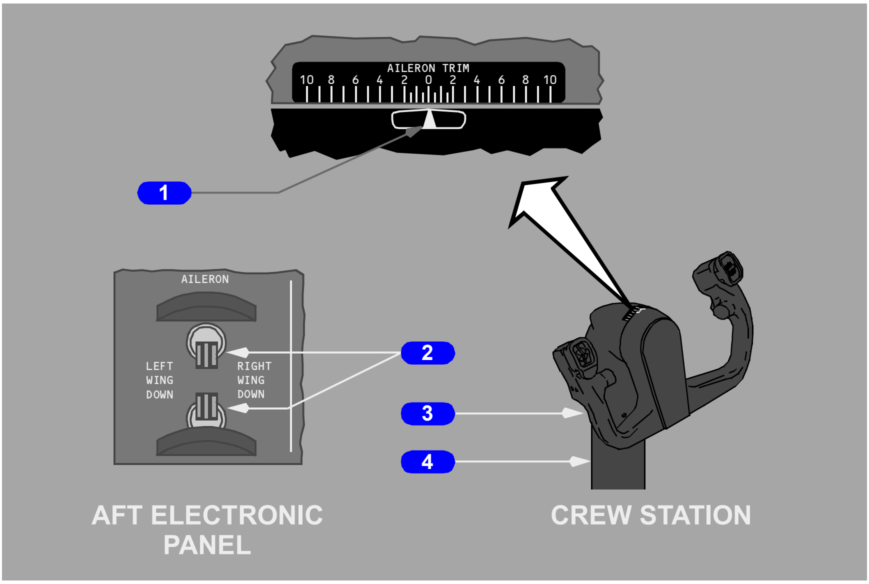
3 Rudder Trim OFF Flag

Illuminated (amber) (in view) – rudder trim indicator is inoperative.

4 Rudder Trim Control (spring-loaded to neutral)

Rotate – electrically trims the rudder in the desired direction.

Aileron / Elevator / Flight Spoilers



1 AILERON TRIM Indicator

Indicates units of aileron trim.

2 AILERON Trim Switches (spring-loaded to the neutral position)

Movement of both switches repositions the aileron neutral control position.

3 Control Wheel

Rotate – operates ailerons and flight spoilers in desired direction.

4 Control Column

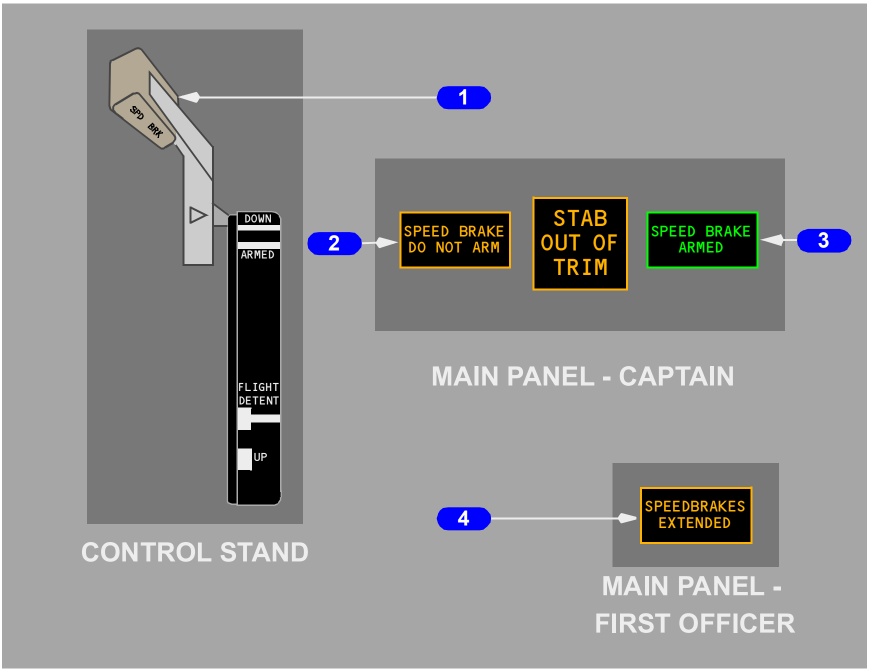
Push –

- operates elevators in the nose down direction
- interrupts main electric, autopilot and Speed Trim System (Speed Trim function and MCAS function) nose up stabilizer trim commands.

Pull –

- operates elevators in the nose up direction
- interrupts main electric, autopilot and Speed Trim function nose down stabilizer trim commands
- does not interrupt MCAS nose down stabilizer trim commands.

Speed Brakes



1 SPD BRK Lever

DOWN (detent) – all flight and ground spoilers in faired position.

ARMED –

- automatic speed brake system armed
- upon touchdown, the SPD BRK lever moves to the UP position, and all flight and ground spoilers extend.

FLIGHT DETENT – all flight spoilers are extended to their maximum position for inflight use.

UP – all flight and ground spoilers are extended to their maximum position for ground use.

2 SPEED BRAKE DO NOT ARM Light

Light deactivated when SPD BRK lever is in the DOWN position.

Illuminated (amber) – indicates a fault within the autospeedbrake system.

3 SPEED BRAKE ARMED Light

Light deactivated when SPD BRK lever is in the DOWN position.

Illuminated (green) – indicates valid automatic speed brake system inputs.

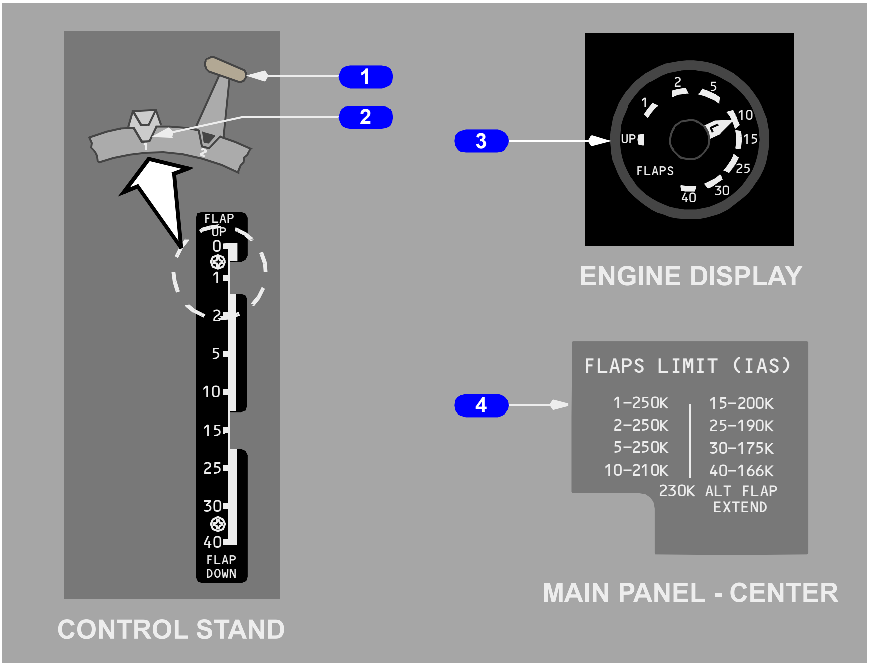
4 SPEEDBRAKES EXTENDED Light

Illuminated (amber) –

- in–flight -
  - SPD BRK lever is beyond the ARMED position, and
    - a thrust lever is above idle for 15 seconds, or
    - a thrust lever is above approximately 40 degrees for 3 seconds.
  - SPD BRK lever is beyond the ARMED position, and
    - TE flaps extended more than flaps 10, or
    - radio altitude less than 800 feet, or
- on the ground -
  - SPD BRK lever is in the DOWN detent,
  - ground spoilers are not stowed.

Note: On the ground, the SPEEDBRAKES EXTENDED light does not illuminate when hydraulic system A pressure is less than 750 psi.

Trailing Edge Flaps



1 FLAP Lever

- selects position of flap control valve, directing hydraulic pressure for flap drive unit
- position of the LE devices is determined by selecting TE flap position
- flap lever positions 10, 15, 25, 30, and 40 arms the flap load relief system.

2 Flap Gates

Prevents inadvertent flap lever movement beyond:

- position 1 - to check flap position for one engine inoperative go-around
- position 15 - to check flap position for normal go-around.

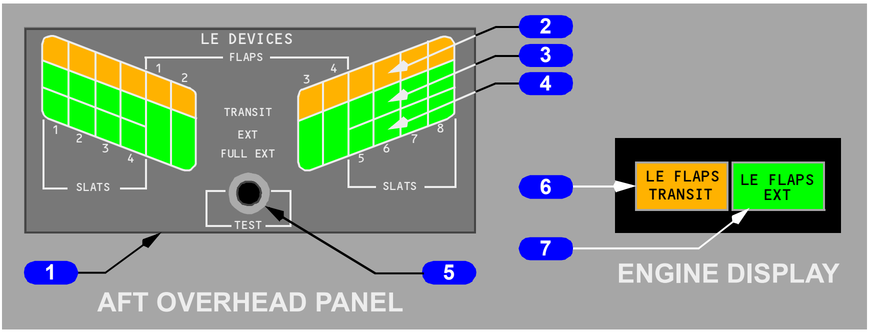
3 Flap Position Indicator

- indicates position of left and right TE flaps
- provides TE flaps asymmetry and skew indication.

4 FLAPS LIMIT Placard

Indicates maximum speed for each flap setting.

Leading Edge Devices



1 Leading Edge Devices (LE DEVICES) Annunciator Panel

Indicates position of individual LE flaps and slats.

Extinguished – related LE device retracted.

2 Leading Edge Devices TRANSIT Lights

Illuminated (amber) – related LE device in transit.

3 Leading Edge Devices Extended (EXT) Lights

Illuminated (green) – related LE slat in extended (intermediate) position.

4 Leading Edge Devices Full Extended (FULL EXT) Lights

Illuminated (green) – related LE device fully extended.

5 Leading Edge Annunciator Panel TEST Switch

Press – tests all annunciator panel lights.

6 Leading Edge Flaps (LE FLAPS TRANSIT) Light

Illuminated (amber) –

- any LE device not in programmed position with respect to TE flaps
- a LE uncommanded motion condition exists (two or more LE flaps or slats have moved away from their commanded position).

Note: Light is inhibited during autoslat operation in flight.

Note: Light is inhibited when trailing edge flap position provided by SMYDs.

7 Leading Edge Flaps Extended (LE FLAPS EXT) Light

Illuminated (green) –

- all LE flaps extended and all LE slats in extended (intermediate) position (TE flap positions 1, 2, 5, 10, 15, and 25)
- all LE devices fully extended (TE flap positions 30 and 40).

Note: Light is inhibited when trailing edge flap position provided by SMYDs.

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Introduction

The primary flight control system uses conventional control wheel, column and pedals linked mechanically to hydraulic power control units which command the primary flight control surfaces: ailerons, elevators and rudder. The flight controls are powered by redundant hydraulic sources; system A and system B. Either hydraulic system can operate all primary flight controls. The ailerons and elevators may be operated manually if required. The rudder may be operated by the standby hydraulic system if system A and system B pressure is not available.

The secondary flight controls, high lift devices consisting of Trailing Edge (TE) flaps and Leading Edge (LE) flaps and slats (LE devices), are powered by hydraulic system B. In the event hydraulic system B fails, the TE flaps can be operated electrically. Under certain conditions the Power Transfer Unit (PTU) automatically powers the LE devices. (Refer to Chapter 13, Hydraulics, Power Transfer Unit). They can also be extended using standby hydraulic pressure.

Pilot Controls

The pilot controls consist of:

- two control columns
- two control wheels
- two pairs of rudder pedals
- SPEED BRAKE lever
- FLAP lever
- STAB TRIM cutout switches
- STAB TRIM override switch
- stabilizer trim switches
- stabilizer trim wheel
- AILERON trim switches
- RUDDER trim control
- YAW DAMPER switch
- ALTERNATE FLAPS master switch
- alternate flaps position switch
- FLT CONTROL switches
- flight SPOILER switches

The columns and wheels are connected through transfer mechanisms which allow the pilots to bypass a jammed control.

There is a rigid connection between both pairs of rudder pedals.

The SPEED BRAKE lever allows manual or automatic symmetric actuation of the spoilers.

Flight Control Surfaces

Pitch control is provided by:

- two elevators
- a movable horizontal stabilizer.

Roll control is provided by:

- two ailerons
- eight flight spoilers.

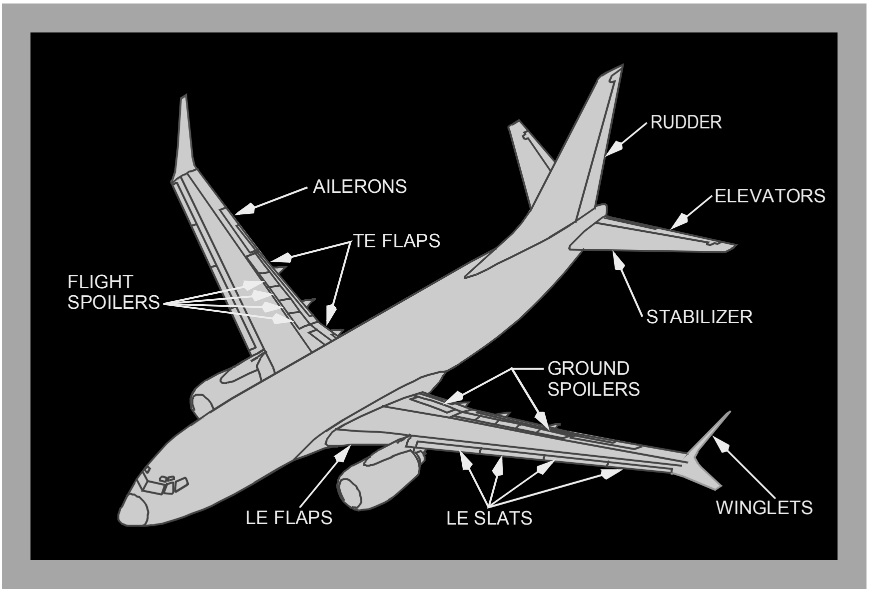
Yaw control is provided by a single rudder. During takeoff, the rudder becomes aerodynamically effective between 40 and 60 knots.

TE flaps and LE flaps and slats provide high lift for takeoff, approach and landing.

Winglets provide enhanced performance, extended range and increased fuel efficiency.

In the air symmetric flight spoilers are used as speed brakes. On the ground symmetric flight and ground spoilers destroy lift and increase braking efficiency.

Flight Control Surfaces Location



Roll Control

The roll control surfaces consist of hydraulically powered ailerons and flight spoilers, which are controlled by rotating either control wheel.

Ailerons

The ailerons provide roll control around the airplane's longitudinal axis. The ailerons are positioned by the pilots' control wheels. The A and B FLT CONTROL switches control hydraulic shutoff valves. These valves can be used to isolate each aileron, as well as the elevators and rudder, from related hydraulic system pressure.

The Captain's control wheel is connected by cables to the aileron Power Control Units (PCUs) through the aileron feel and centering unit. The First Officer's control wheel is connected to the Spoiler Control Electronics (SCE) unit via wheel position sensors. A control wheel input drives the aileron control quadrant, which provides input to two Power Control Units (PCUs), actuating both ailerons. With total hydraulic power failure the ailerons can be mechanically positioned by rotating the pilots' control wheels. Control forces are higher due to friction and aerodynamic loads.

Aileron Transfer Mechanism

In the event of a lateral system jam, force applied to the Captain's and the First Officer's control wheels will identify which system, ailerons or spoilers, is usable and which control wheel, Captain's or First Officer's, can provide roll control. If the aileron control system is jammed, force applied to the First Officer's control wheel provides roll control from the spoilers. The ailerons and the Captain's control wheel are inoperative. If the First Officer's control wheel is jammed, force applied to the Captain's control wheel provides roll control from the ailerons. The spoilers and the First Officer's control wheel are inoperative.

Aileron Trim

Dual AILERON trim switches, located on the aft electronic panel, must be pushed simultaneously to command trim changes. The trim electrically repositions the aileron feel and centering unit, which causes the control wheel to rotate and redefines the aileron neutral position. The amount of aileron trim is indicated on a scale on the top of each control column.

If aileron trim is used with the autopilot engaged, the trim is not reflected in the control wheel position. The autopilot overpowers the trim and holds the control wheel where it is required for heading/track control. Any aileron trim applied when the autopilot is engaged can result in an out of trim condition and an abrupt rolling movement when the autopilot is disengaged.

Flight Spoilers

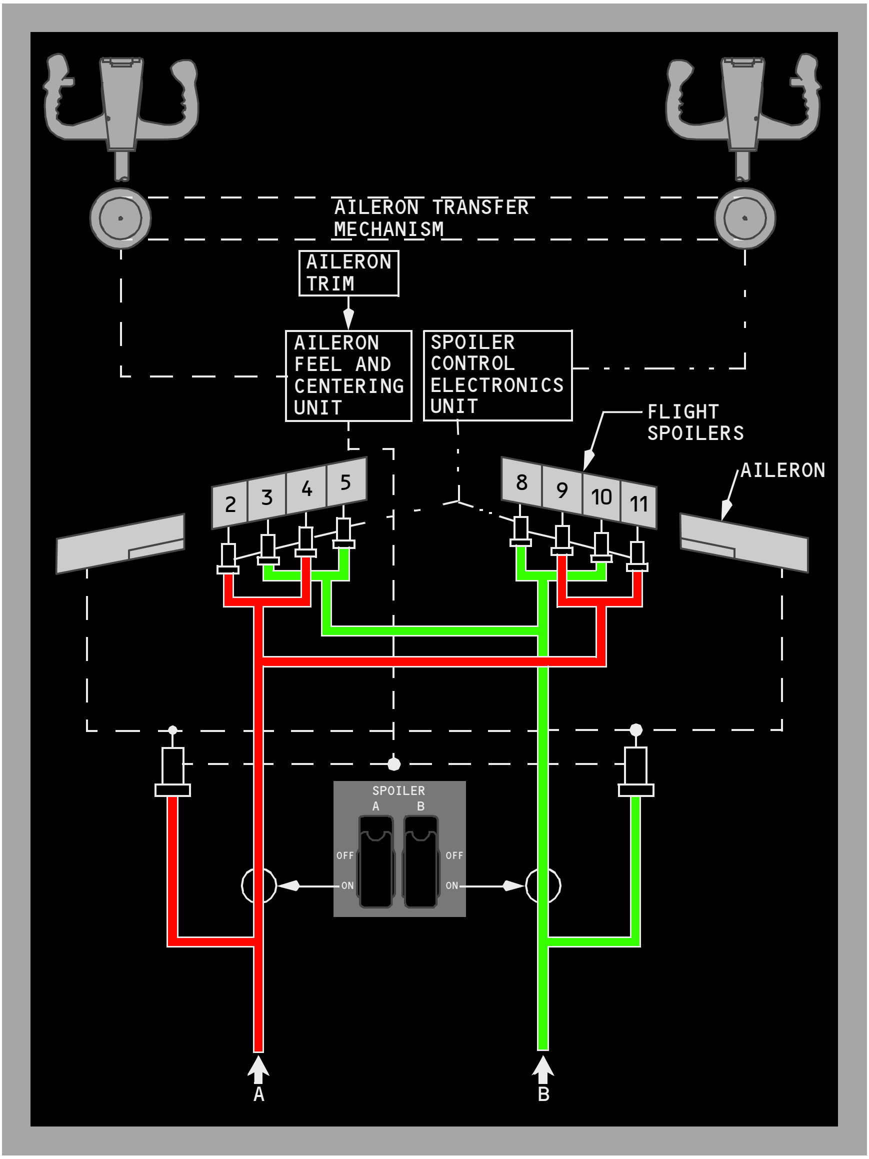
Four flight spoilers are located on the upper surface of each wing. Each hydraulic system, A and B, is dedicated to a different set of spoiler pairs to provide isolation and maintain symmetric operation in the event of hydraulic system failure. Hydraulic pressure shutoff valves are controlled by the two flight SPOILER switches.

Flight spoilers are used as speed brakes to increase drag and reduce lift, both in flight and on the ground. The flight spoilers also supplement roll control in response to control wheel commands.

Under normal conditions, roll commands are transmitted from the First Officer's control wheel sensors to the SCE unit, which mixes roll commands with speedbrake commands from sensors on the speedbrake lever and sends the spoiler extension commands to each of the flight spoilers.

The flight spoilers rise on the wing with up aileron and remain faired on the wing with down aileron. When the control wheel is displaced more than approximately 10°, spoiler deflection is initiated.

Roll Control Schematic



Pitch Control

The pitch control surfaces consist of hydraulically powered elevators and an electrically powered stabilizer. The elevators are controlled by forward or aft movement of the control column. The stabilizer is controlled by autopilot trim or manual trim.

Elevators

The elevators provide pitch control around the airplane's lateral axis. The elevators are positioned by the pilots' control columns. The A and B FLT CONTROL switches control hydraulic shutoff valves for the elevators.

Cables connect the pilots' control columns to elevator Power Control Units (PCUs) which are powered by hydraulic system A and B. The elevators are interconnected by a torque tube. With loss of hydraulic system A and B the elevators can be mechanically positioned by forward or aft movement of the pilots' control columns. Control forces are higher due to friction and aerodynamic loads.

Elevator Control Column Override Mechanism

In the event of a control column jam, an override mechanism allows the control columns to be physically separated. Applying force against the jam will breakout either the Captain's or First Officer's control column. Whichever column moves freely after the breakout can provide adequate elevator control.

Although total available elevator travel is significantly reduced, there is sufficient elevator travel available for landing flare. Column forces are higher and exceed those experienced during manual reversion. If the jam exists during the landing phase, higher forces are required to generate sufficient elevator control to flare for landing. Stabilizer trim is available to counteract the sustained control column force.

Elevator Jam Landing Assist System

If a jam occurs in the aft elevator control mechanism, both control columns have a limited range of motion. During approach and landing, the Elevator Jam Landing Assist System uses the flight spoilers for small changes to the flight path. To activate the system, the Elevator Jam Landing Assist switch must be selected ON, the actual flap position must be 1 or greater, and the autopilot must be disengaged.

With the system activated, the flight spoilers deploy to a preset position. The control wheel steering force sensors detect forces applied to the control column. A push on the control column causes the spoilers to extend farther, increasing the descent rate. A pull on the control column causes the spoilers to retract, decreasing the descent rate.

Elevator Feel System

The elevator feel computer provides simulated aerodynamic forces using airspeed (from the elevator pitot system) and stabilizer position. Feel is transmitted to the control columns by the elevator feel and centering unit. To operate the feel system the elevator feel computer uses either hydraulic system A or B pressure, whichever is higher. When either hydraulic system or elevator feel pitot system fails, excessive differential hydraulic pressure is sensed in the elevator feel computer and the FEEL DIFF PRESS light illuminates.

Mach Trim System

A Mach trim system provides speed stability at the higher Mach numbers. Mach trim is automatically accomplished above Mach .615 by adjusting the elevators with respect to the stabilizer as speed increases. The flight control computers use Mach information from the ADIRU to compute a Mach trim actuator position. The Mach trim actuator repositions the elevator feel and centering unit which adjusts the control column neutral position.

Stabilizer

The horizontal stabilizer is positioned by a single electric trim motor controlled through either the stab trim switches on the control wheel or autopilot trim. The stabilizer may also be positioned by manually rotating the stabilizer trim wheel.

Stabilizer Trim

Main electric stabilizer trim switches on each control wheel actuate the electric trim motor through the main electric stabilizer trim circuit when the airplane is flown manually. With the autopilot engaged, stabilizer trim is accomplished through the autopilot stabilizer trim circuit. The main electric and autopilot stabilizer trim have two speed modes: high speed with flaps extended and low speed with flaps retracted. In addition, with flaps extended, the autopilot trim stops stabilizer nose up trim commands when airspeed is three knots or more into the minimum maneuver speed (amber) bar. If the autopilot is engaged, actuating either pair of main electric stabilizer trim switches automatically disengages the autopilot. The stabilizer trim wheels rotate whenever main electric stabilizer trim is actuated.

The STAB TRIM PRI cutout switch and the STAB TRIM B/U cutout switch are located on the control stand. If either switch is positioned to CUTOUT, the autopilot, main electric and Speed Trim System (Speed Trim function and MCAS function) trim inputs are disconnected from the stabilizer trim motor.

Control column actuated stabilizer trim cutout switches interrupts operation of main electric stabilizer trim, autopilot trim and the Speed Trim function when the control column movement opposes trim direction. Aft control column movement does not interrupt Maneuvering Characteristics Augmentation System (MCAS) nose down trim commands. Forward control column movement interrupts MCAS nose up trim commands.

In addition to the control column actuated stabilizer trim cutout switches, the FCC contains a software column cutout function which adds a layer of redundancy to mitigate a latent failure of the column cutout switches. The control column cutout function interrupts operation of autopilot trim and the Speed Trim function when the control column movement opposes trim direction. Aft control column movement does not interrupt MCAS nose down trim commands. Forward control column movement interrupts MCAS nose up trim commands. The software column cutout function cuts out automatic stabilizer commands beyond the cutout position of the control column actuated stabilizer trim cutout switches. Main electric stabilizer trim commands are not inhibited.

When the STAB TRIM override switch is positioned to OVRD, main electric stabilizer trim can be used regardless of control column position.

Manual stabilizer control is accomplished through cables which allow the pilot to position the stabilizer by rotating the stabilizer trim wheels. The stabilizer is held in position by two independent brake systems. Manual rotation of the trim wheels can be used to set the desired stabilizer position, after the STAB TRIM cutout switches have been placed in the CUTOUT position. The effort required to manually rotate the stabilizer trim wheels may be higher under certain flight conditions such as at high airspeeds. Grasping the stabilizer trim wheel will stop stabilizer motion.

Stabilizer Trim Operation with Forward or Aft CG

In the event the stabilizer is trimmed to the end of the electrical trim limits, additional trim is available through the use of the manual trim wheels. If manual trim is used to position the stabilizer beyond the electrical trim limits, the stabilizer trim switches may be used to return the stabilizer to electrical trim limits.

Stabilizer Position Indication and Green Band

Stabilizer position is displayed in units on two STAB TRIM indicators located inboard of each stabilizer trim wheel. The STAB TRIM indicators also display the TAKEOFF green band indication.

The trim authority for main electric and autopilot trim is less than that for manual trim.

- Main Electric Trim
  - flaps extended 0.05 to 14.5 units
  - flaps retracted 3.95 to 14.5 units
- Autopilot Trim 0.05 to 14.5 units
- Manual Trim -0.20 to 16.9 units.

The green band range of the STAB TRIM indicator shows the takeoff trim range. An intermittent horn sounds if takeoff is attempted with the stabilizer trim outside the takeoff trim range.

Speed Trim System

The Speed Trim System (STS) provides speed and pitch stability augmentation. Speed stability augmentation is provided by the Speed Trim function in the Speed Trim System. Pitch stability augmentation is provided by the MCAS function in the Speed Trim System. The Speed Trim System only operates while the autopilot is not engaged. If the SPEED TRIM FAIL light is illuminated, Speed Trim System (Speed Trim function and MCAS function) operation is inhibited. Main electric stabilizer trim switches can be used to override Speed Trim System inputs.

If the left and right AOAs disagree by 5.5 degrees or more with the flaps retracted, the SPEED TRIM FAIL light illuminates and the Speed Trim System (Speed Trim function and MCAS function) is inhibited for the remainder of the flight.

Note: The Speed Trim System (Speed Trim function and MCAS function) is inhibited with either the STAB TRIM PRI cutout switch or the STAB TRIM B/U cutout switch in the CUTOUT position.

Speed Trim Function

Speed trim is a speed stability augmentation function designed to improve flight characteristics during operations with low gross weight, aft center of gravity and high thrust when the autopilot is not engaged. The purpose is to return the airplane to a trimmed speed by commanding the stabilizer in a direction opposite the speed change. The Speed Trim function monitors inputs of stabilizer position, thrust lever position, flap position, airspeed and vertical speed to determine the amount of stabilizer trim and rate at which to control the stabilizer trim motor. As the airplane speed increases or decreases from the trimmed speed, the stabilizer is commanded in the direction needed to return the airplane to the trimmed speed. This increases control column forces to encourage return to the trimmed speed. As the airplane returns to the trimmed speed, the commanded stabilizer movement is removed.

The Speed Trim function contains a High AOA mode that is used to provide increased stabilizer commands at elevated AOA. As AOA increases toward stick shaker, the Speed Trim function transitions to the High AOA mode to command additional nose down stabilizer to increase control column forces. AOA is used only to transition into and out of the High AOA mode and does not determine the amount of stabilizer command.

The Speed Trim function controls the stabilizer trim motor at a high rate with flaps extended and low rate with flaps retracted.

The Speed Trim function operates most frequently during takeoff, climb and go-around. Conditions for operation are listed below:

- Up to Mach 0.68
- 10 seconds after takeoff
- 5 seconds following release of main electric stabilizer trim switches
- Autopilot not engaged
- Sensing of trim requirement

Maneuvering Characteristics Augmentation System (MCAS) Function

MCAS is a pitch stability augmentation function designed to operate at elevated angles of attack (AOAs). The purpose is to increase control column forces by commanding the stabilizer in the nose down direction at elevated AOAs.

The MCAS function becomes active when the airplane exceeds a threshold AOA. Stabilizer trim inputs in the nose down direction are added incrementally if AOA continues to increase. Stabilizer trim commands are based on AOA and Mach number. As AOA is reduced below threshold AOA, the commanded stabilizer trim is removed. If AOA is again increased above threshold AOA, MCAS becomes active and again commands stabilizer trim inputs in the nose down direction. The MCAS function controls the stabilizer trim motor at the flaps extended Speed Trim function rate.

The FCC uses a corrected AOA value to activate MCAS. This logic uses both AOA vanes and filters out small differences between the vanes and provides a single corrected value to the MCAS function.

The MCAS function contains logic that limits the amount of nose down stabilizer trim movement to preserve elevator authority for pitch control. When MCAS activates, the command limit logic computes a nose down stabilizer trim limit. If stabilizer trim reaches the computed limit, the SPEED TRIM FAIL light illuminates and the Speed Trim System (Speed Trim function and MCAS function) is inhibited for the remainder of the flight. Manual stabilizer trim, main electric stabilizer trim and autopilot trim are not affected by the command limit logic. The command limit logic inhibits the Speed Trim System when the computed nose down stabilizer trim limit is reached:

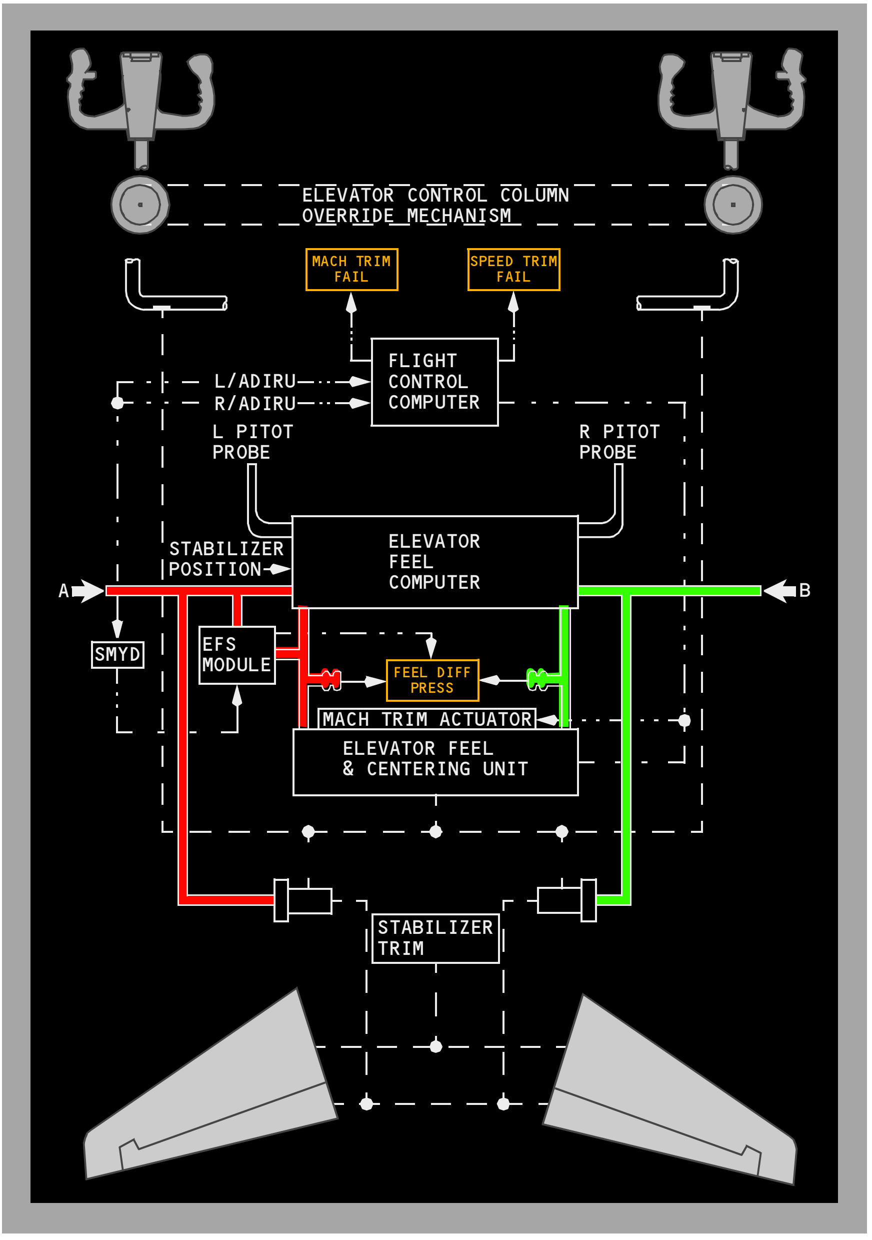
- within five minutes following MCAS activation, or
- before the autopilot has been engaged for one continuous minute following MCAS activation.

The command limit logic is reset after five minutes or after the autopilot has been engaged for one minute, whichever occurs first.

Conditions for operation are listed below:

- AOA above threshold
- Up to Mach 0.84
- 10 seconds after takeoff
- Flaps up
- Autopilot not engaged

Pitch Control Schematic



Stall Identification

Stall identification and control is enhanced by the yaw damper, the Elevator Feel Shift (EFS) module and the Speed Trim System. These three systems work together to help the pilot identify and prevent further movement into a stall condition.

During high AOA operations, the Stall Management/Yaw Damper (SMYD) reduces yaw damper commanded rudder movement.

The EFS module increases hydraulic system A pressure to the elevator feel and centering unit during a stall. This approximately doubles control column forces. The EFS module is armed whenever an inhibit condition is not present. Inhibit conditions are: on the ground, radio altitude less than 100 feet and autopilot engaged. However, if EFS is active when descending through 100 feet RA, it remains active until AOA is reduced below approximately stick shaker threshold. There are no flight deck indications that the system is properly armed or activated.

As airspeed decreases towards stall speed with flaps down, the Speed Trim System uses the Speed Trim function to trim the stabilizer nose down above stick shaker AOA. With flaps up, as AOA approaches stick shaker, the stabilizer nose down trim commands transition from the Speed Trim function to the MCAS function. These trim schedules produce a predictable and increasing column force with increasing aft column displacement. With the column aft, the amount of column force increase is more pronounced with the onset of EFS.

Flight Control Computer Monitors

The Flight Control Computers contain monitors which provide protection against possible runaway stabilizer conditions caused by erroneous FCC stabilizer trim commands. The FCCs continuously monitor each other’s stabilizer trim commands, and in the event an erroneous command is detected, stabilizer trim commands, autopilot trim commands, and CWS trim commands are stopped and inhibited for the remainder of the flight for that FCC. These trim commands are then provided by the other FCC. In addition, main electric stabilizer trim remains available.

Autopilot Elevator Monitor

The Autopilot Elevator Monitor protects against erroneous elevator commands that can result in erroneous autopilot stabilizer trim commands. The Autopilot Elevator Monitor is available when:

- Autopilot is engaged, in single channel, and
- Pitch mode is other than G/S or G/P, and
- Flaps are 15 or less.

If the Autopilot Elevator Monitor activates:

- The STAB OUT OF TRIM light illuminates in flight and remains illuminated until the condition is no longer present or the autopilot is disengaged.
- The STAB OUT OF TRIM light illuminates after landing when groundspeed is less than 30 knots.

Note: The Speed Trim System remains available.

Stabilizer Cross-FCC Trim Monitor

The Cross-FCC Trim Monitor protects against erroneous stabilizer trim commands. The Cross-FCC Trim Monitor is available when a single autopilot is engaged and during manual flight.

If the Cross-FCC Trim Monitor activates:

- The autopilot or CWS can automatically disengage causing the associated aural and visual alerts.
- The SPEED TRIM FAIL light can illuminate automatically, during MASTER CAUTION recall, or not at all.
- The STAB OUT OF TRIM light illuminates after landing when groundspeed is less than 30 knots.

Yaw Control

Yaw control is accomplished by a hydraulically powered rudder and a digital yaw damper system. The rudder is controlled by displacing the rudder pedals. The yaw damping functions are controlled through the Stall Management/Yaw Damper (SMYD) computers.

Rudder

The rudder provides yaw control about the airplane's vertical axis. The A and B FLT CONTROL switches control hydraulic shutoff valves for the rudder and the standby rudder.

Each set of rudder pedals is mechanically connected by cables to the input levers of the main and standby rudder PCUs. The main PCU consists of two independent input rods, two individual control valves, and two separate actuators; one for Hydraulic system A and one for Hydraulic system B. The standby rudder PCU is controlled by a separate input rod and control valve and powered by the standby hydraulic system. All three input rods have individual jam override mechanisms that allows input commands to continue to be transferred to the remaining free input rods if an input rod or downstream hardware is hindered or jammed.

With both engines operating above approximately 135 kts, both hydraulic system A and B pressure are each reduced within the main PCU by approximately 25% each. This function limits full rudder authority in flight after takeoff and before landing. It operates the same in the air and on the ground. It will disengage if a difference in engine speed is detected.

The main rudder PCU contains a Force Fight Monitor (FFM) that detects opposing pressure (force fight) between A and B actuators. This may occur if either system A or B input is jammed or disconnected. The FFM output is used to automatically turn on the Standby Hydraulic pump, open the standby rudder shutoff valve to pressurize the standby rudder PCU, and illuminate the STBY RUD ON, Master Caution, and Flight Control (FLT CONT) lights.

The standby rudder PCU is powered by the standby hydraulic system. The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. With the standby PCU powered the pilot retains adequate rudder control capability. It can be operated manually through the FLT CONTROL switches or automatically. (Refer to Chapter 13, Hydraulics, Standby Hydraulic System)

An amber STBY RUD ON light illuminates when the standby rudder hydraulic system is pressurized. The standby rudder system can be pressurized with either Flight Control switch, automatically during takeoff or landing (Refer to Chapter 13, Hydraulics, Standby Hydraulic System) or automatically by the Force Fight Monitor. The STBY RUD ON light illumination activates Master Caution and Flight Control warning lights on the Systems Annunciation Panel.

Rudder Trim

The RUDDER trim control, located on the aft electronic panel, electrically repositions the rudder feel and centering unit which adjusts the rudder neutral position. The rudder pedals are displaced proportionately. The RUDDER TRIM indicator displays the rudder trim position in units.

Yaw Damper

The yaw damper system consists of a main and standby yaw damper. Both yaw dampers are controlled through Stall Management/Yaw Damper (SMYD) computers. The SMYD computers receive inputs from both ADIRUs, both control wheels and the YAW DAMPER switch. SMYDs provide yaw damper inputs to the main rudder Power Control Unit (PCU) or standby rudder PCU, as appropriate.

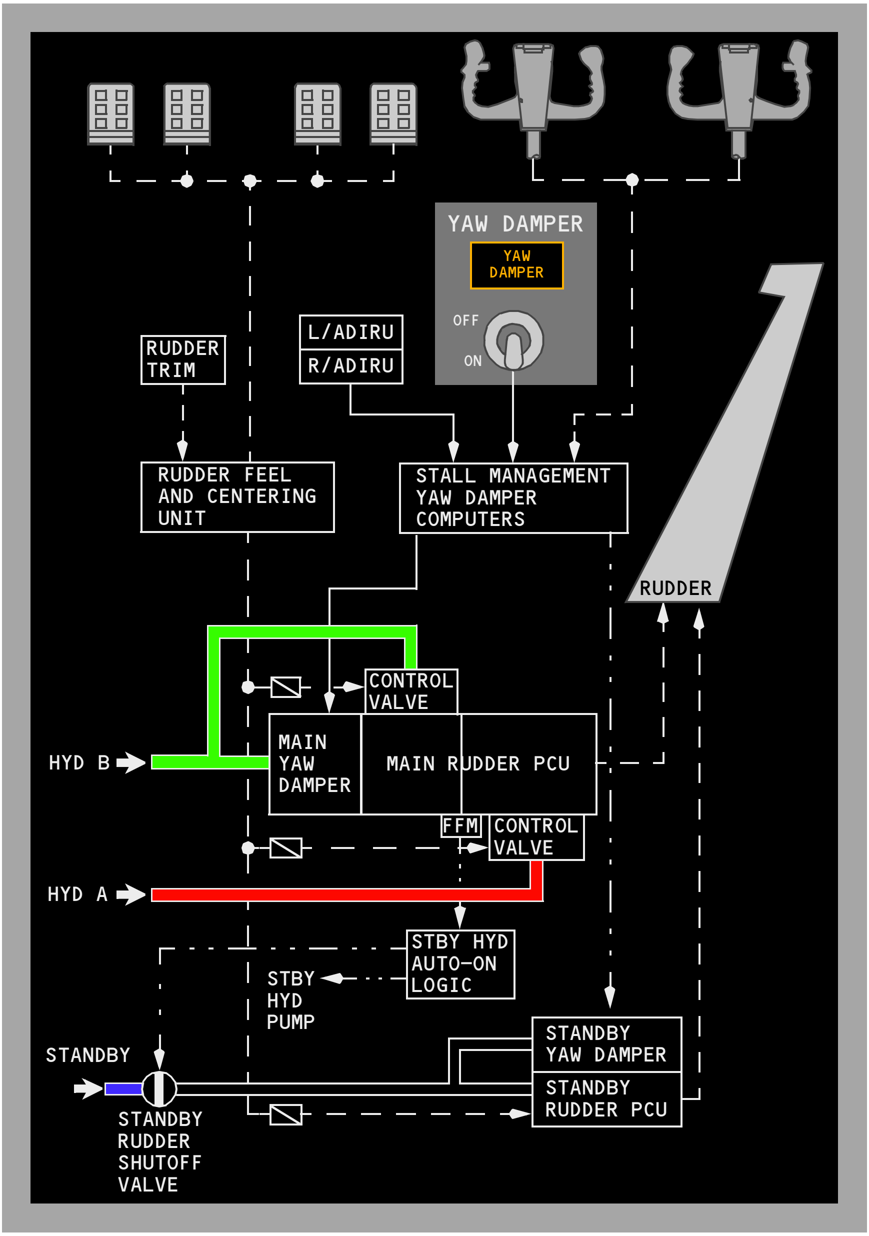
Either yaw damper is capable of providing dutch roll prevention, gust damping and turn coordination. Yaw damper operation does not result in rudder pedal movement. The pilot can override either main or standby yaw damper inputs using either the rudder pedals or trim inputs.

During normal operation the main yaw damper uses hydraulic system B and the SMYD computers provide continuous system monitoring. The YAW DAMPER Switch automatically moves to OFF, the amber YAW DAMPER light illuminates and the YAW DAMPER switch cannot be reset to ON when any of the following conditions occur:

- SMYD senses a yaw damper system fault,
- SMYD senses that the yaw damper does not respond to a command,
- B FLT CONTROL switch is positioned to OFF or STBY RUD.

During manual reversion flight (loss of hydraulic system A and B pressure), both FLT CONTROL switches are positioned to STBY RUD. In this case, the YAW DAMPER switch can be reset to ON and the standby hydraulic system powers the standby yaw damper. During Standby Yaw Damper operation, movement of the control wheel sends a signal to the standby rudder PCU to move the rudder. This gives rudder assist to help turn the airplane when control of the ailerons is through manual reversion.

Yaw Control Schematic



Speed Brakes

The speed brakes consist of flight spoilers and ground spoilers. Hydraulic system A powers all four ground spoilers, two on the upper surface of each wing. The SPEED BRAKE lever controls the spoilers. When the SPEED BRAKE lever is raised all the spoilers extend when the airplane is on the ground and only the flight spoilers extend when the airplane is in the air.

The spoiler control system consists of: the Spoiler Control Electronics (SCE) unit; position sensors attached to the control wheel and SPD BRK lever; eight hydraulically powered, electrically controlled flight spoiler actuators and the Ground Spoiler Control Module (GSCM), which controls six ground spoiler actuators.

The SPEEDBRAKES EXTENDED light provides an indication of spoiler operation in-flight and on the ground. In-flight, the light illuminates to warn the crew that the speed brakes are extended while in the landing configuration or below 800 feet AGL. It also illuminates if the speedbrakes are extended and the thrust levers are greater than idle for 15 seconds, or a thrust lever is greater than approximately 40 degrees for 3 seconds. On the ground, the light illuminates when hydraulic pressure is sensed in the ground spoiler shutoff valve with the speed brake lever in the DOWN position.

In-Flight Operation

Operating the SPD BRK lever in flight causes all flight spoilers to rise symmetrically to act as speed brakes.

Speedbrake commands are electronically limited at the FLIGHT DETENT. In the event electrical power to the SCE is lost, all spoilers are inoperative and will retract if extended.

Maneuver Load Alleviation

The Maneuver Load Alleviation (MLA) system reduces wing and aft fuselage bending loads during certain maneuvers and normal load factors. The MLA system retracts extended speedbrakes during maneuvers that result in higher load factors at certain gross weights. The SPD BRK lever does not move during MLA activation. When the conditions for MLA are no longer present, the speedbrakes will return to the selected position.

Landing Attitude Modifier

The Landing Attitude Modifier (LAM) system performs two functions. The first LAM function applies when the flaps are in the 30 or 40 position. To maintain acceptable nose landing gear contact margin, LAM symmetrically deploys flight spoilers on approach to reduce lift and force the airplane to use a higher angle of attack. The amount of spoiler deflection depends on the approach speed. Deflection begins at approximately 10 knots above VREF.

The second LAM function applies when flaps are positions 15 through 30 and the thrust levers are near idle. This function also symmetrically deploys flight spoilers, in order to generate additional drag.

Emergency Descent Speedbrakes

In order to minimize exposure time of passengers and crew to high cabin altitude, an Emergency Descent Speedbrakes (EDS) function is included. EDS is armed when the airplane is above 30,000 feet and the cabin altitude warning is active. Moving the speedbrake lever activates the function. When activated, the EDS raises the speedbrakes to a higher than normal position when the speedbrake lever is in the flight detent. EDS is deactivated when the spoilers are stowed, or when the cabin altitude warning is no longer active.

Ground Operation

During landing, the auto speed brake system operates when these conditions occur:

- SPEED BRAKE lever is in the ARMED position
- SPEED BRAKE ARMED light is illuminated
- radio altitude is less than 6 feet
- landing gear strut compresses on touchdown

  Note: Wheel spinup or compression of any landing gear strut enables the flight spoilers to deploy. Compression of both main landing gear struts enables the ground spoilers to deploy.

- both thrust levers are retarded to IDLE
- main landing gear wheels spin up (more than 60 kts)

The SPEED BRAKE lever automatically moves to the UP position and the spoilers deploy.

If a wheel spin-up signal is not detected, when the air/ground system senses ground mode (any gear strut compresses) the SPEED BRAKE lever moves to the UP position and flight spoiler panels deploy automatically.

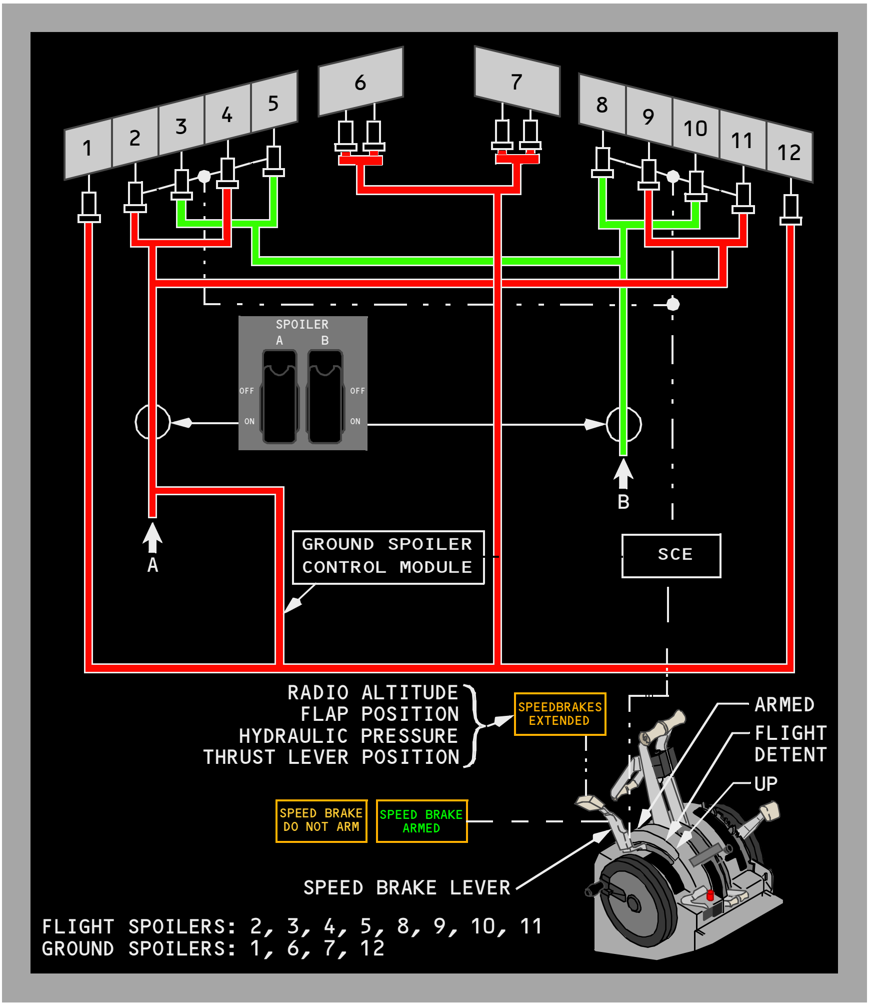
If the SPEED BRAKE lever is in the DOWN position during landing or rejected takeoff, the auto speed brake system operates when these conditions occur:

- main landing gear wheels spin up (more than 60 kts)
- both thrust levers are retarded to IDLE
- reverse thrust levers are positioned for reverse thrust.

The SPEED BRAKE lever automatically moves to the UP position and spoilers deploy.

After an RTO or landing, if either thrust lever is advanced, the SPEED BRAKE lever automatically moves to the DOWN detent and all spoilers retract. The spoilers may also be retracted by manually moving the SPEED BRAKE lever to the DOWN detent.

Speed Brakes Schematic



Flaps and Slats

The flaps and slats are high lift devices that increase wing lift and decrease stall speed during takeoff, low speed maneuvering and landing.

LE devices consist of four flaps and eight slats: two flaps inboard and four slats outboard of each engine. Slats extend to form a sealed or slotted leading edge depending on the TE flap setting. The TE devices consist of double slotted flaps inboard and outboard of each engine.

TE flap positions 1–15 provide increased lift; positions 15–40 provide increased lift and drag. Flaps 15, 30 and 40 are normal landing flap positions. Flaps 15 is normally limited to airports where approach climb performance is a factor. Runway length and conditions must be taken into account when selecting a landing flap position.

Flap and Slat Sequencing

LE devices and TE flaps are normally extended and retracted by hydraulic power from system B. When the FLAP lever is in the UP detent, all flaps and LE devices are commanded to the retracted or up position. Moving the FLAP lever aft allows selection of flap detent positions 1, 2, 5, 10, 15, 25, 30, or 40. The LE devices deployment is sequenced as a function of TE flaps deployment.

When the FLAP lever is moved from the UP position to the 1, 2, 5, 10, 15, or 25 position, the TE flaps extend to the commanded position and the LE:

- flaps extend to the full extended position and
- slats extend to the extend position.

When the FLAP lever is moved beyond the 25 position the TE flaps extend to the commanded position and the LE:

- flaps remain at the full extended position and
- slats extend to the full extended position.

The LE devices sequence is reversed upon retraction.

Mechanical gates hinder inadvertent FLAP lever movement beyond flaps 1 for one engine inoperative go–around and flaps 15 for normal go–around.

Indicator lights on the engine display provide overall LE devices position status. The LE DEVICES annunciator panel on the aft overhead panel indicates the positions of the individual flaps and slats.

Flap Load Relief

Flap load relief protects the trailing edge flaps from excessive air loads. Flap load relief is a function of the Flap Slat Electronic Unit (FSEU), which receives data from the left Air Data Inertial Reference Unit (ADIRU). The left ADIRU is also the source for the captain's airspeed indication. When the captain's indicated airspeed is too high for the selected flap setting, flap load relief activates and retracts the TE flaps to the next lower setting below the selected flap lever position.

If the Captain's airspeed is erroneously high, the flap load relief function can activate and retract the flaps to the next lower setting from the flap detent selected with the flap lever. In this case the desired flap position can be achieved by selecting the next higher flap detent beyond the desired flap position. For example, if the desired flap position is Flaps 30, select Flaps 40 and the flaps will extend to the Flaps 30 position. This applies for all flap selections protected by flap load relief.

When the flap load relief function activates, the FLAP lever does not move, but the flap position indicator shows flap retraction and re–extension.

Flap load relief is available when flaps are selected to 10, 15,25,30, or 40. Flap load relief is not available during alternate flap extension.

When the flaps are set at 40, the TE flaps:

- retract to 30 if airspeed exceeds 167 knots
- re–extend when airspeed is reduced below 162 knots.

When the flaps are set at 30, the TE flaps:

- retract to 25 if the airspeed exceeds 176 knots
- re–extend when airspeed is reduced below 171 knots.

When the flaps are set at 25, the TE flaps:

- retract to 15 if the airspeed exceeds 191 knots
- re–extend when airspeed is reduced below 186 knots.

When the flaps are set at 15, the TE flaps:

- retract to 10 if the airspeed exceeds 201 knots
- re–extend when airspeed is reduced below 196 knots.

When the flaps are set at 10, the TE flaps:

- retract to 5 if the airspeed exceeds 211 knots
- re–extend when airspeed is reduced below 206 knots.

Autoslats

Autoslat operation is normally powered by hydraulic system B. An alternate source of power is provided by system A through a Power Transfer Unit (PTU) if a loss of pressure is sensed from the higher volume system B engine driven pump. The PTU uses system A pressure to power a hydraulic motorized pump, pressurizing system B fluid to provide power for the autoslat operation. (Refer to Chapter 13, Hydraulics, Power Transfer Unit)

At flap positions 1, 2, 5, 10, 15, and 25 an autoslat function is available that moves the LE slats to full extended if the airplane approaches a stall.

The autoslat system is designed to enhance airplane stall characteristics at high angles of attack during takeoff or approach to landing. When TE flaps 1 through 25 are selected, the LE slats are in the extend position. As the airplane approaches the stall angle, the slats automatically begin driving to the full extended position prior to stick shaker activation. The slats return to the extend position when the pitch angle is sufficiently reduced below the stall critical attitude.

Alternate Extension

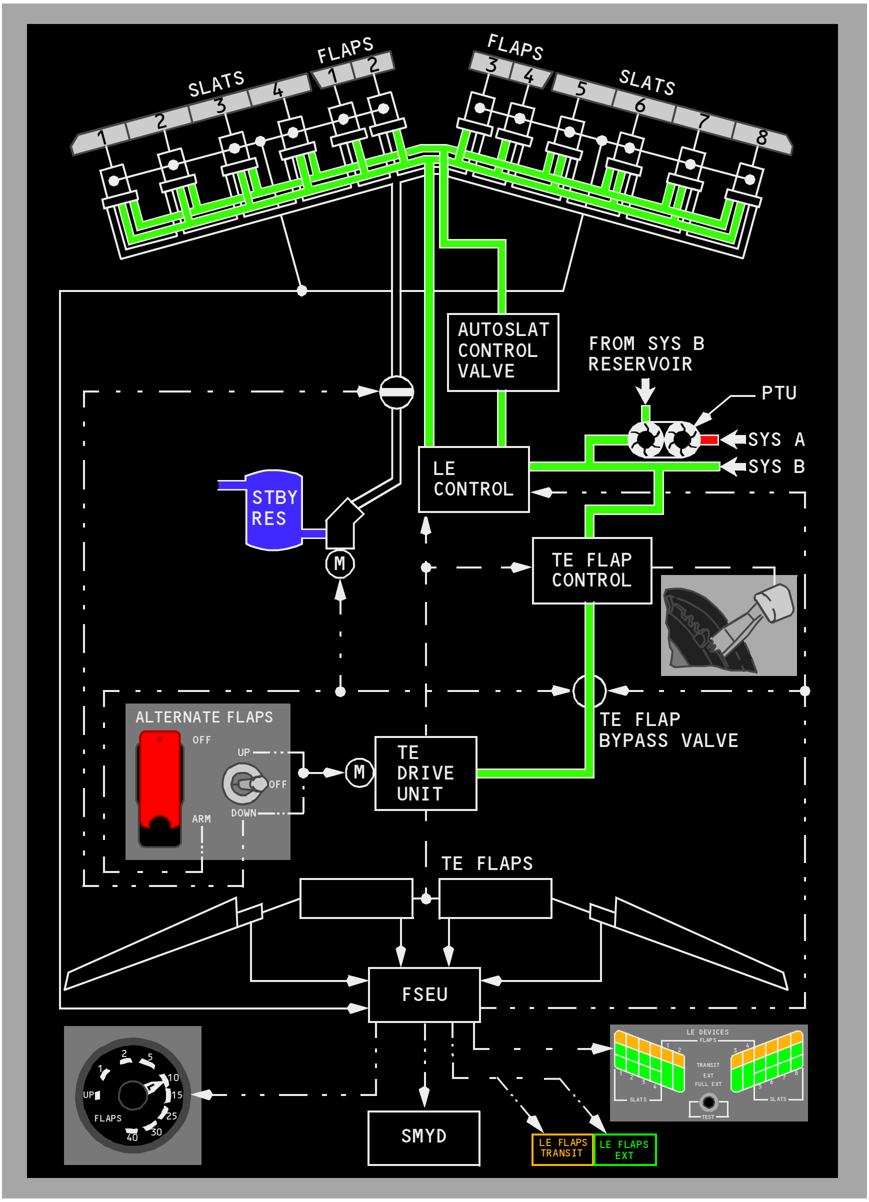
In the event that hydraulic system B fails, an alternate method of extending the LE devices and extending and retracting the TE flaps is provided.

The TE flaps can be operated electrically through the use of two alternate flap switches. The guarded ALTERNATE FLAPS master switch closes a flap bypass valve to prevent hydraulic lock of the flap drive unit and arms the alternate flaps position switch. The ALTERNATE FLAPS position switch controls an electric motor that extends or retracts the TE flaps. The switch must be held in the DOWN position until the flaps reach the desired position. No asymmetry or skew protection is provided through the alternate (electrical) flap drive system.

When using alternate flap extension the LE flaps and slats are driven to the full extended position using power from the standby hydraulic system. In this case the ALTERNATE FLAPS master switch energizes the standby pump and the ALTERNATE FLAPS position switch, held in the down position momentarily, fully extends the LE devices.

Note: The LE devices cannot be retracted by the standby hydraulic system.

Leading Edge Devices and Trailing Edge Flaps Schematic



Asymmetry and Skew Detection and Protection

The Flap Slat Electronic Unit (FSEU) continuously monitors the position of wing LE and TE high lift devices. If a device on one wing does not align with the symmetrical device on the other wing, there is an asymmetry condition. A skew condition occurs when symmetrical TE flaps do not operate at the same rate causing the panels to twist during extension or retraction. Should a skew occur, the FSEU automatically protects against roll by maintaining flap symmetry.

Trailing Edge Flap Position Indication

Wing TE position indications come from the FSEU. When the FSEU detects a TE asymmetry or skew condition, the FSEU:

- closes the TE flap bypass valve
- displays a needle split on the flap position indicator
- shows position of left and right wing trailing edge flaps.

Leading Edge Device Improper Position Indication

Wing LE position indications come from the FSEU. When the FSEU detects a LE device in an improper position, the LE FLAPS TRANSIT light remains illuminated and one of the following indications is displayed on the LE DEVICES annunciator panel:

- TRANSIT (amber) - Leading edge devices are in transit, or are not in the selected position.
- EXT (green) - Leading edge slats and flaps in extend position, or are in the selected position.
- FULL EXT (green) - Leading edge slats are in the full extend position.
- No lights illuminated - Leading edge devices are in the retract position.

Uncommanded Motion Detection, Protection and Indication

The FSEU provides protection from uncommanded motion by the LE devices or TE flaps.

Leading Edge Uncommanded Motion

Uncommanded motion is detected when no TE flap position or autoslat command is present and:

- two LE flaps move on one wing, or
- two or more slats move on one wing.

The FSEU shuts down the LE control and illuminates the amber LE FLAPS TRANSIT light.

In addition, to prevent uncommanded motion from occurring on the LE devices during cruise, the FSEU maintains pressure on the retract lines and depressurizes the extend and full extend lines.

Trailing Edge Uncommanded Motion

Uncommanded motion is detected when no FLAP lever or flap load relief command is present and the TE flaps:

- move away from the commanded position
- continue to move after reaching a commanded position, or
- move in a direction opposite to that commanded.

The FSEU shuts down the TE drive unit by closing the TE flap bypass valve. The TE flap shutdown cannot be reset by the flight crew and they must use the alternate flap system to control TE flaps. The shutdown is indicated by the flap position indicator disagreeing with the FLAP lever position. There is no flap needle split.

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Flight Instruments, Displays — Chapter 10
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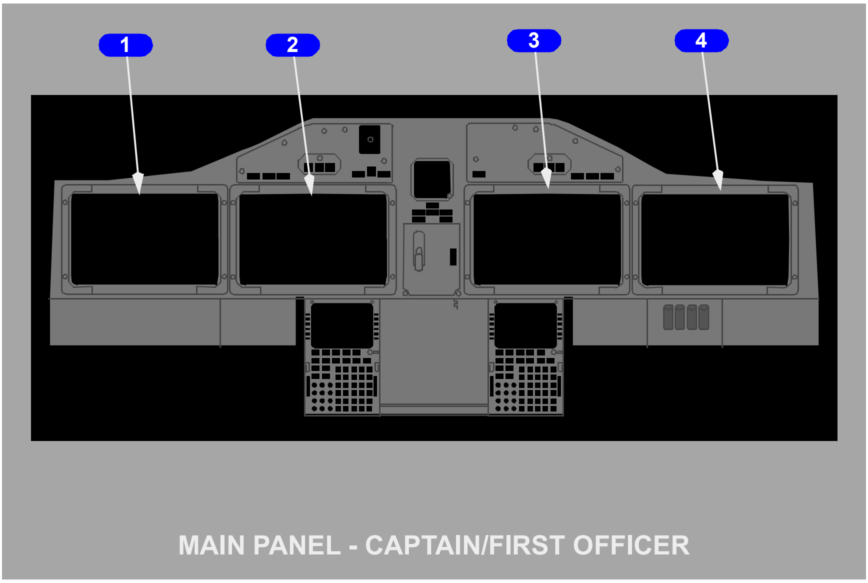
Large Format Display System – Overview
Display Units



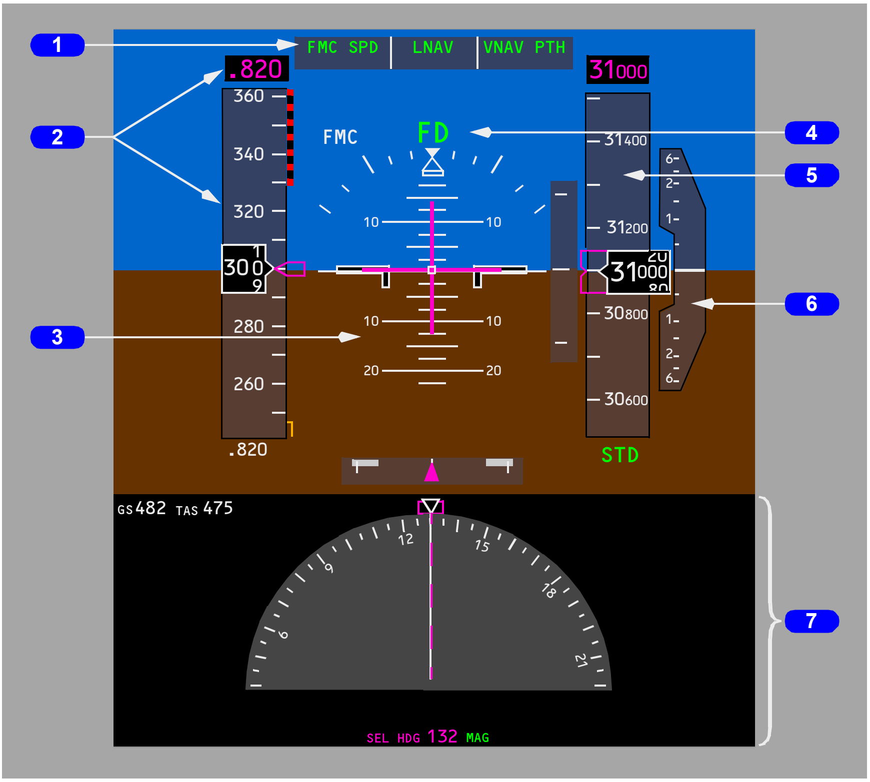
1 Captain Outboard Display Unit

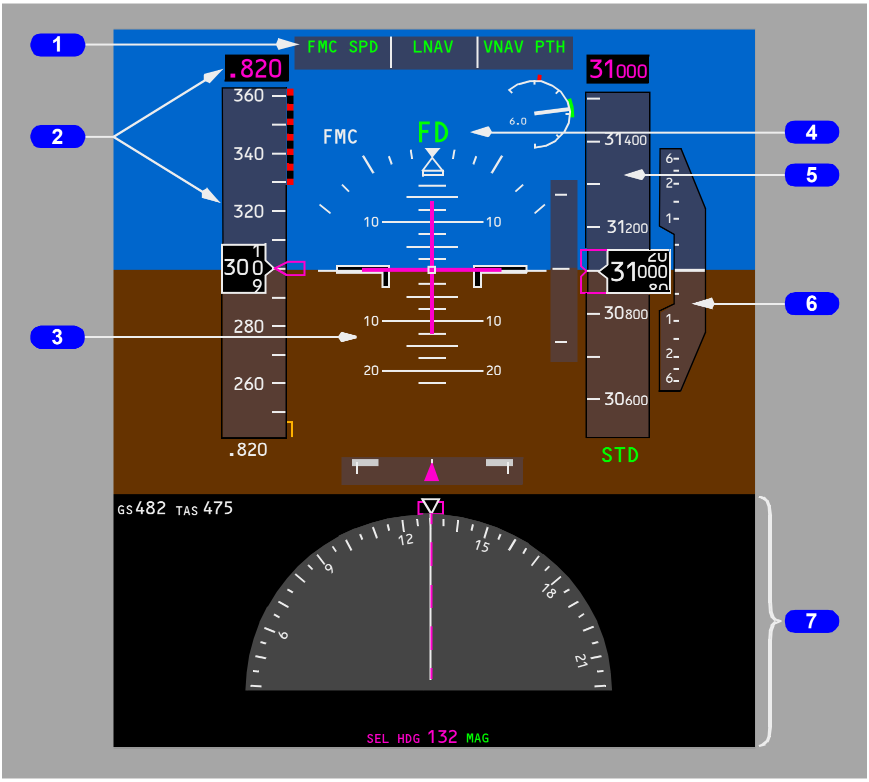
2 Captain Inboard Display Unit

3 First Officer Inboard Display Unit

4 First Officer Outboard Display Unit

Outboard Display Units





1 **Flight Mode Annunciator**

Displays current flight modes; refer to Chapter 4, Automatic Flight.

2 **Airspeed/Mach Indications**

3 **Attitude Indications**

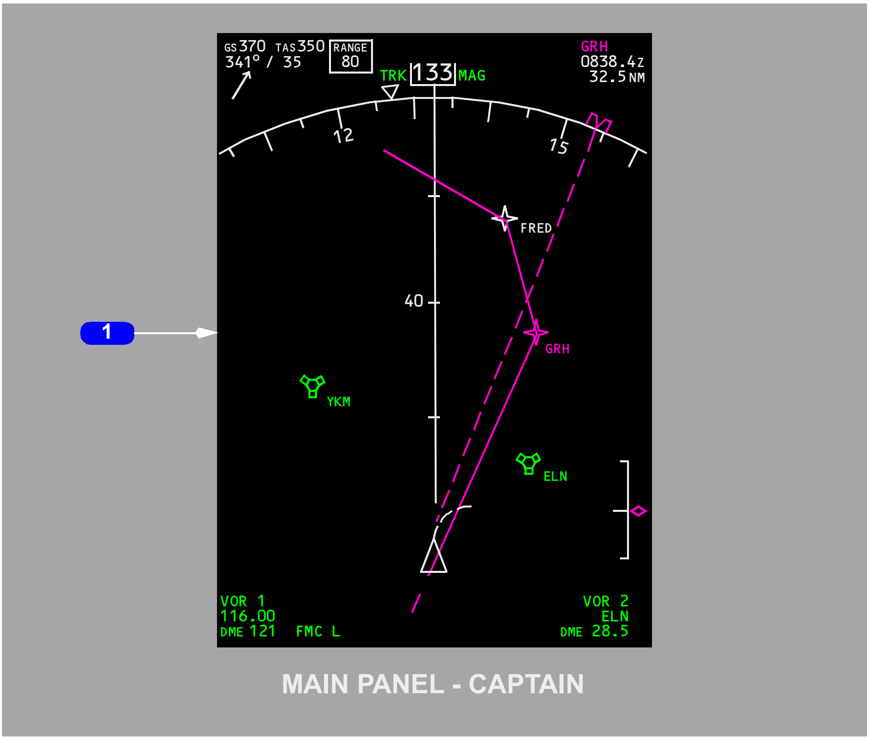
4 **Autopilot, Flight Director System Status**

5 **Altitude Indications**

6 **Vertical Speed Indication**

7 **Heading, Track and Speed Indications**

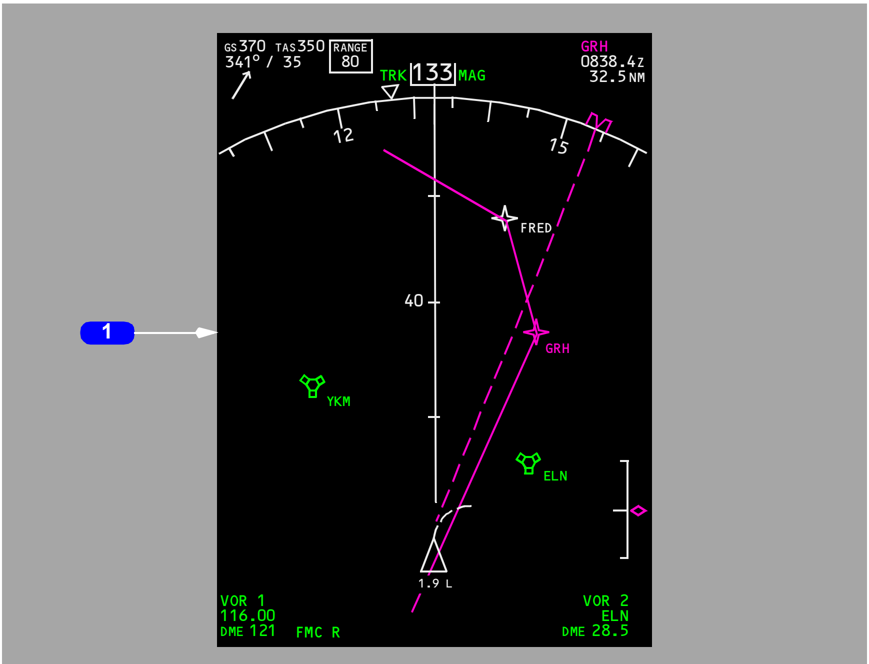
Captain Inboard Display



1 **Navigation Display**

Displays map, approach, VOR, or plan modes as selected on the EFIS control panel.

First Officer Inboard Display



MAIN PANEL - FIRST OFFICER

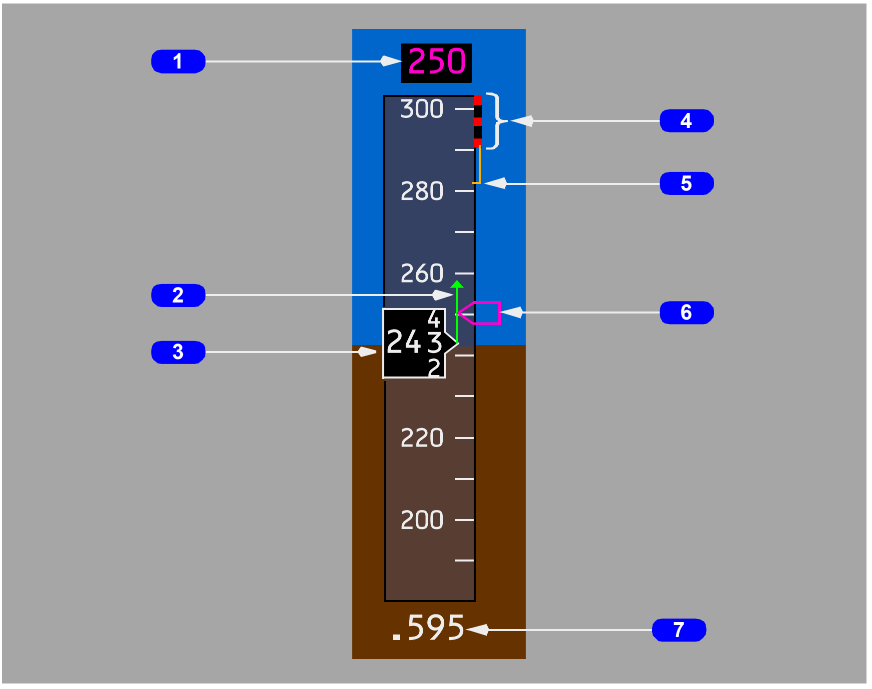
1 Navigation Display

Displays map, approach, VOR, or plan modes as selected on the EFIS control panel.

PFD Airspeed Indications

Airspeed Indications – General

The PFD airspeed indication displays air data inertial reference system (ADIRS) airspeed and other airspeed related information.



1 Selected Speed (magenta)

Displays target airspeed:

- indicates the airspeed manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

2 Speed Trend Vector (green)

Tip of arrow indicates predicted airspeed in the next 10 seconds based on the current airspeed and acceleration.

3 Current Airspeed (white)

Indicates current calibrated airspeed when above 45 knots.

When current airspeed decreases into the minimum maneuver speed amber bar:

- airspeed readout box turns amber and flashes for 10 seconds
- box returns to white when airspeed is above minimum maneuver speed.

4 Maximum Operating Speed (red and black)

Bottom of the bar indicates the maximum speed as limited by the lowest of the following:

- Vmo/Mmo
- landing gear placard speed
- flap placard speed.

5 Maximum Maneuver Speed/High Speed Buffet (amber)

When flaps are up, the bottom of the amber bar indicates the maximum maneuver speed. This airspeed provides 1.3g maneuver capability to high speed buffet (or an alternative approved maneuver capability set in the FMC maintenance pages). The bar may be displayed when operating at high altitude at relatively high gross weights.

Note: 1.3g maneuver capability occurs at 40 degrees of bank in level flight.

6 Speed Bug (magenta)

Points to the airspeed:

- manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

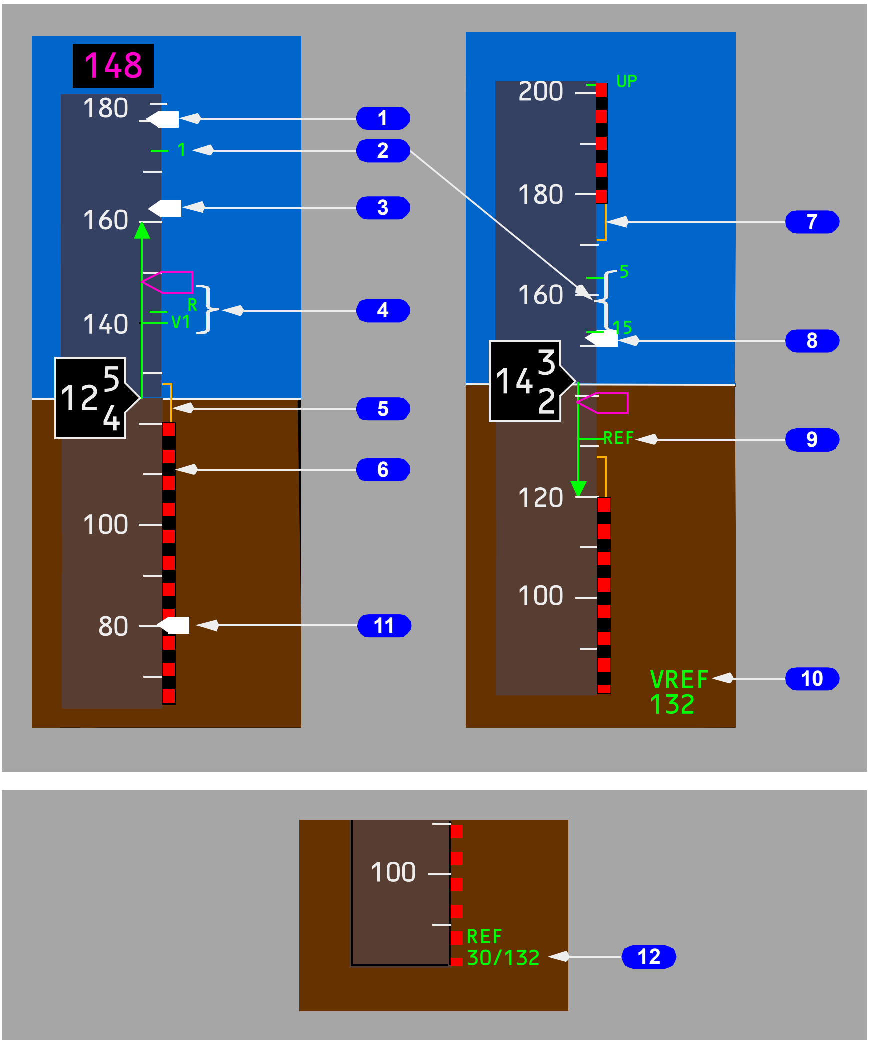
When the selected speed is off scale, the bug is parked at the top or bottom of the tape, with only one half bug visible.

7 Current Mach (white)

Indicates current Mach number:

- displays when airspeed is 0.40 Mach and above
- blanks when airspeed decreases below 0.40 Mach.

Airspeed Indications – Takeoff and Approach



1 Spare Bug (white)

Displayed if the SPD REF radio button is in the SET position on the N1/SPD REF SET display and a value greater than 60 knots has been selected. Not available if the SPD REF AUTO radio button is selected.

2 Flaps Maneuvering Speeds (green)

Indicates flap maneuvering speed for the displayed flap position:

- displayed after gross weight is entered in the CDU or after takeoff gross weight is set with the SPD REF radio button
- when the V2+15 bug is displayed for takeoff, the flap maneuvering speed bug for the current flap setting is not displayed, except for flaps 1 takeoff
- numbered flap maneuvering speed bugs are removed when flap lever is moved to flaps 30 or 40
- flap bugs inhibited if less than V2/VREF +4
- UP bug not displayed above approximately 20,000 feet altitude.

3 V2+15 (white)

Displayed for takeoff.

Removed when either of the following occurs:

- at first flap retraction
- when VREF is entered in the CDU.

4 Takeoff Reference Speeds (green)

Indicates V1 (decision speed “V1”) and VR (rotation speed “VR”) as selected on the CDU TAKEOFF REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the Speed Reference radio buttons:

- amber NO VSPD is displayed on the ground if V1 and VR are not selected on the CDU or are not set with the Speed Reference radio buttons
- displayed for takeoff when speed is greater than 80 knots
- removed at lift–off
- V1 speed is displayed at the top of airspeed indication when selected and value is off scale
- V1 is automatically called out by voice aural.

5 Minimum Maneuver Speed (amber)

The amber bar is displayed with the first flap retraction after takeoff or when a valid Vref is entered.

Top of amber bar indicates minimum maneuver speed. This airspeed provides

- 1.3g maneuver capability to stick shaker below approximately 20,000 ft.
- 1.3g maneuver capability to low speed buffet (or an alternative approved maneuver capability set in the FMC maintenance pages) above approximately 20,000 ft.

Note: 1.3g maneuver capability occurs at 40 degrees of bank in level flight.

CAUTION: Reduced maneuver capability exists when operating within the amber regions below the minimum maneuver speed or above the maximum maneuver speed. During non-normal conditions the target speed may be below the minimum maneuver speed.

6 Minimum Speed (red and black)

Top of bar indicates the speed at which stick shaker occurs.

7 Maximum Maneuver Speed/Next Flap Position Placard Speed (amber)

Shortly after takeoff the amber bar may be displayed until airspeed exceeds 160 knots or until first flap retraction.

When flaps are not up, the bottom of the amber bar indicates the placard speed for the next normal flap setting. The display logic is based on a normal flap setting sequence of 1, 5, 15, 30, 40. The bar is removed when the flap handle is moved to the landing flap setting selected on the APPROACH REF page or when the flap lever is moved to flaps 40. It is also removed with any flap retraction.

8 VREF+20 (white)

Displayed with selection of VREF.

9 Landing Reference Speed (green)

Indicates REF (reference speed) as selected on the CDU APPROACH REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the Speed Reference radio buttons on the N1/SPD REF SET display.

REF speed is displayed at the bottom of airspeed indication when selected and value is off scale.

10 Speed Reference Display (green)

Reflects the selection on the N1/SPD REF SET display:

- label can say V1, VR, WT LBS, WT KG, MAN SPD, and INVALID ENTRY.
- numerics show the value for the given selection.
- MAN SPD indicates that the SPD REF setting is in SET and not in AUTO.

11 80 Knot Airspeed Bug (white)

Indicates 80 knots:

- displayed automatically during preflight
- removed at first flap retraction or when VREF is entered.

12 **Flap/VREF Speed Annunciation (green) (as installed)**

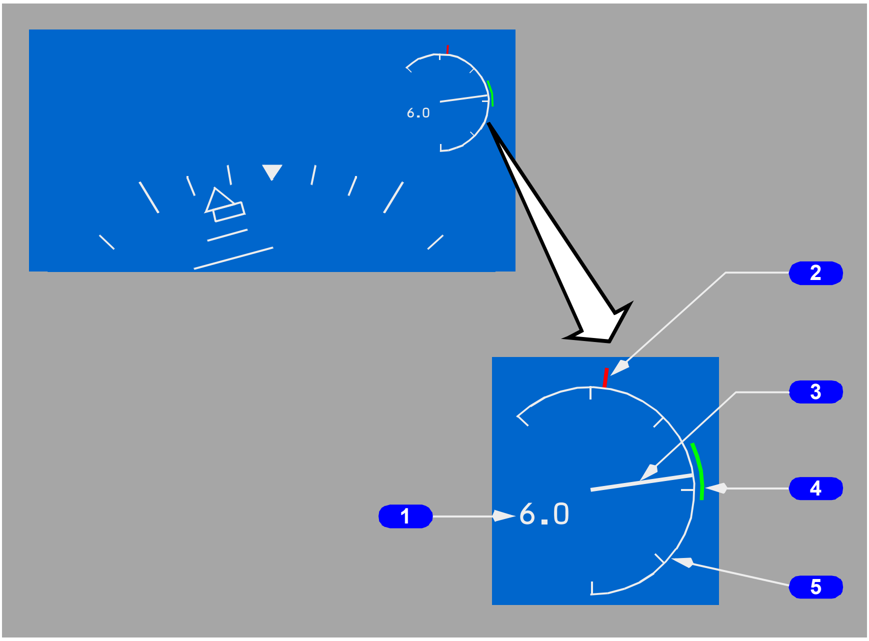
Indicates selected landing flap position and VREF as selected on the CDU APPROACH REF page:

- displayed for flaps 15, 30 and 40
- not shown for VREF set with the Speed Reference radio buttons.

PFD Angle of Attack (AOA) Indications

Angle of Attack Indications - General

The angle of attack indications display ADIRU aircraft body angle of attack.



1 **Digital AOA Readout (white)**

Indicates digital AOA value to the nearest 0.2 degrees. When on the ground and ground speed less than 80 knots, the readout is fixed at 0.0 degrees.

2 **Stick Shaker Indicator (red)**

Indicates point at which stick shaker activation occurs for existing flight conditions.

Blank if AOA signal is invalid.

3 Analog Needle (white)

Indicates analog AOA value.

- needle travel is limited to a range of – 6 degrees and +21 degrees
- fixed at 0.0 degrees when on the ground and ground speed is less than 80 knots.

4 Approach Reference Band (green)

Indicates appropriate range of approach AOA for a Vref(xx) + 5 approach.

- displayed when in normal or single engine landing flaps (15, 30, 40)
- moves with flap position
- inhibited on takeoff and initial climb.

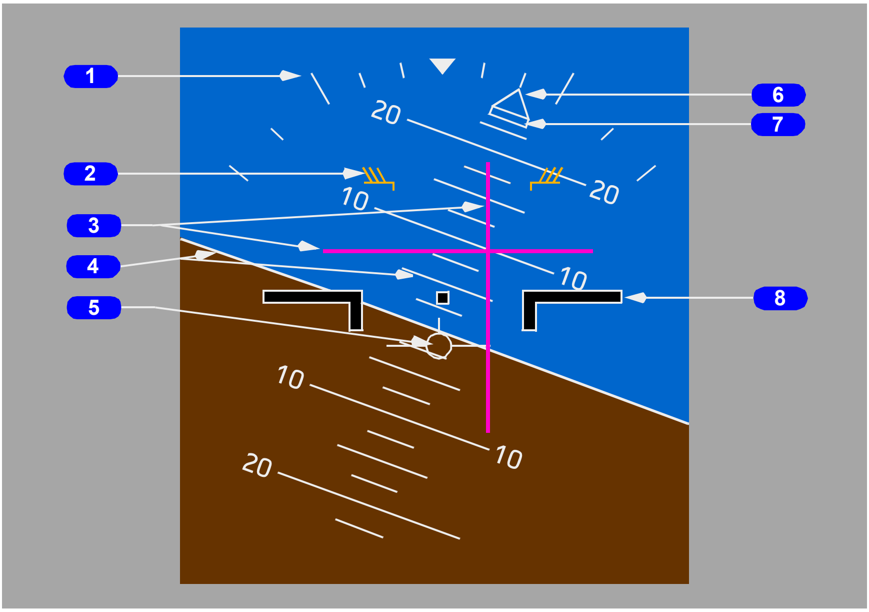
5 Zero Degree Reference Line (white)

Indicates zero degrees angle of attack. Reference lines are displayed every 5 degrees from – 5 degrees to +20 degrees.

PFD – Attitude Indications

Attitude Indications – General

The attitude indication displays ADIRS attitude information.



1 Bank Scale (white)

Provides fixed reference for the bank pointer; scale marks are at 0, 10, 20, 30, 45, and 60 degrees.

2 Pitch Limit Indication (amber)

Indicates pitch limit (stick shaker activation for existing flight conditions).

- displayed when the flaps are not up.
- displayed at slow speeds with the flaps up.

3 Flight Director Bar (magenta)

Indicates flight director steering commands. (Refer to Chapter 4, Automatic Flight).

4 Horizon Line and Pitch Scale (white)

Indicates the horizon relative to the airplane symbol; pitch scale is in 2.5 degree increments.

5 Flight Path Vector (FPV) Indication (white)

Displays flight path angle and drift when selected on the EFIS control panel:

- flight path angle is displayed relative to the horizon line
- drift angle is displayed relative to display center.

6 Bank Pointer

Indicates bank angle; fills and turns amber if bank angle is 35 degrees or more.

- indicates direction towards wings level.

7 Slip/Skid Indication

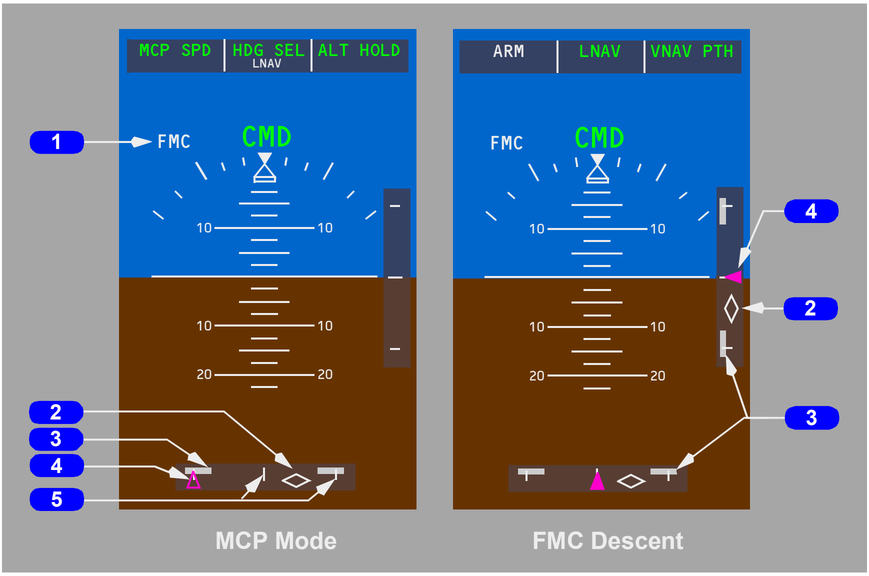
Displaces beneath the bank pointer to indicate slip or skid:

- fills white at full scale deflection
- turns amber if bank angle is 35 degrees or more; fills amber if the slip/skid indication is also at full scale deflection.

8 Airplane Symbol

Indicates airplane attitude relative to the horizon.

Navigation Performance Scales (NPS) Indications



1 Navigation Source Reference

- indicates the source of displayed deviation for each scale
- displayed when LNAV, VNAV, HDG SEL, or TO/GA are engaged
- displayed when current aircraft position is laterally within 1nm or 2 x RNP of the flight plan route – will go out of NPS if lateral limits exceeded
- Possible annunciations include:
  - •LNAV/VNAV – (LNAV and VNAV deviations)
  - •LOC/VNAV – (ILS localizer course with VNAV deviation)
  - •FAC/VNAV – (IAN final approach course with VNAV deviation)
  - •LNAV/ G/S – (LNAV deviation with glideslope)
  - •LNAV/ G/P – (LNAV deviation with IAN glide path)
  - •LOC/ G/P – (ILS localizer course with IAN glide path)
  - •ILS – (ILS approach)
  - •FMC – (IAN approach)
  - •GLS – (GLS approach)

2 **Anticipation Cues**

- displayed if valid approach course deviation information is being received while corresponding NPS deviation scale and pointer are displayed.
- an unfilled white diamond symbol.
- if engaged lateral mode subsequently transitions to LOC, lateral NPS deviation indications will be removed, and normal ILS localizer indications will be displayed
- if engaged vertical mode subsequently transitions to G/S, vertical NPS deviation indications will be removed, and normal ILS G/S indications will be displayed.

3 **Actual Navigation Performance (ANP) Bars**

- lateral/vertical indication of available flight technical error remaining based on total system error
- lateral ANP bars can be displayed in all phases of flight
- vertical ANP bars can be displayed only after reaching top-of-descent
- originate from outer scale and expand inward as a function of increasing ANP relative to RNP
- will just touch at center of scale when ANP equals RNP
- turn from white to amber if current deviation is within the ANP bar limits for 5 continuous seconds.

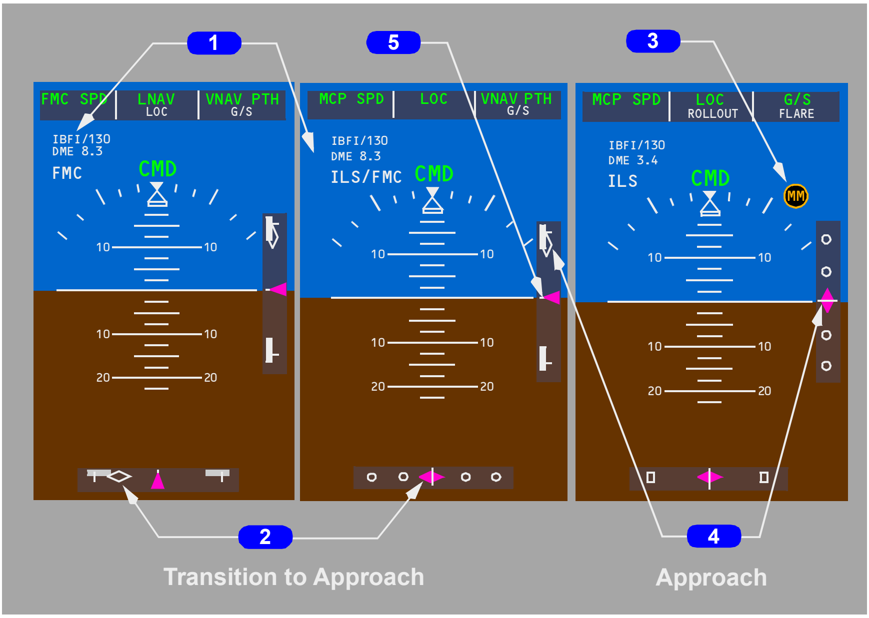
4 **NPS Pointer**

- a filled magenta symbol when it is not parked at deflection limit
- an unfilled pointer outline when at deflection limit
- indicates lateral/vertical paths relative to the airplane
- will flash for 10 seconds if deviation is within ANP bar limits for 5 continuous seconds.

5 **NPS Deviation Scale**

- lateral NPS deviation scale represents current FMC lateral RNP
- vertical NPS deviation scale represents current FMC vertical RNP
- center white tic mark represents airplane position.
- displayed if an approach mode is not engaged and either HDG SEL, TO/GA, LNAV or any VNAV mode is engaged.
- turns amber if the deviation pointer tip is positioned in the ANP bar for 5 continuous seconds.

Instrument Landing System Indications



1 Approach Reference

Displays the selected ILS frequency or identifier, approach course, ILS/DME/FMC distance and source annunciation.

If the tuned ILS frequencies disagree (for longer than one minute), the frequency turns amber with an amber horizontal line until set identically.

If the approach courses entered in the MCP disagree (for longer than one minute), the course turns amber with an amber horizontal line through it.

The navigation source annunciation on the third line is completely independent of the approach data on the first two lines. It identifies the source of navigation performance for the deviation scales.

2 Localizer Pointer and Deviation Scale

The pointer:

- indicates localizer position relative to the airplane
- in view when the localizer signal is received
- fills in solid magenta when within 2 ½ dots from center.

The scale:

- indicates deviation
- in view when the localizer frequency is tuned
- expands when the localizer is engaged and deviation is slightly more than ½ dot.

At low radio altitudes with autopilot engaged the scale turns amber and the pointer flashes to indicate excessive localizer deviation.

Below 1,000 feet AGL, with LNAV engaged and LOC armed, the localizer scale turns amber and the pointer flashes if the localizer is not captured.

Each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second LOC deviation alerting display on each attitude indicator.

3 Marker Beacon symbol

Flashes (and audible) when over one of the marker beacons:

OM (cyan) – outer marker beacon (two dashes per second).

MM (amber) – middle marker beacon (alternate dot and dash).

IM (white) – inner marker beacon (only dots).

4 Glideslope Pointer and Deviation Scale

The pointer:

- indicates glideslope position
- in view when the glideslope signal is received
- fills in solid magenta when within 2 ½ dots from center.
- the pointer is not displayed when the track and the front course on the mode control panel differ by more than 90 degrees (backcourse).

The scale:

- indicates deviation
- in view when the localizer frequency is tuned.

The scale is in view after the frequency is tuned if NPS are not shown. If either LNAV or VNAV is active, or LNAV is armed, the NPS indications remain in view until glideslope capture.

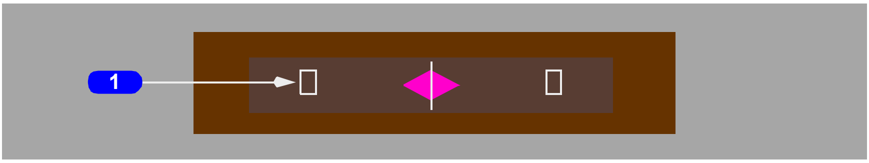
At low radio altitudes with autopilot engaged the scale turns amber and the pointer flashes to indicate excessive glideslope deviation.

Each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second G/S deviation alerting display on each attitude indicator.

5 **NPS Deviation Pointer**

Indicates the navigation path relative to the airplane position.

Expanded Localizer Indications



1 **Expanded Localizer Scale**

Note: The Localizer Scale does not expand for IAN approaches.

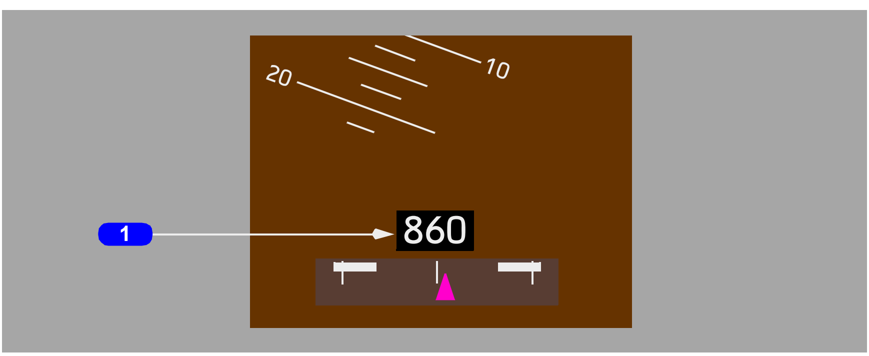
Displayed when the autopilot or flight director is in LOC mode, deviation is slightly more than ½ dot and track is within 5 degrees of the MCP selected course.

As deviation increases, the deviation pointer remains filled in solid magenta and parks at the limit of the expanded scale. Once the deviation reaches the equivalent of 2.4 dots from center on the standard scale, the pointer becomes unfilled.

Reverts to standard scale when out of LOC mode, and groundspeed is less than 30 knots or radio altitude is greater than 200 feet.

A rectangle equals ½ dot deviation.

Radio Altitude Indications

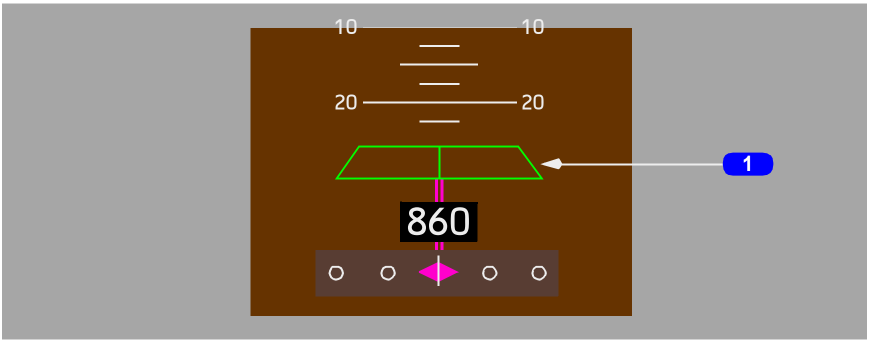


1 **Radio Altitude**

Displays current radio altitude:

- displayed below 2500 feet AGL
- box highlighted white for 10 seconds upon descent below 2500 feet
- turns amber when below radio altitude minimums.

PFD Rising Runway Indications



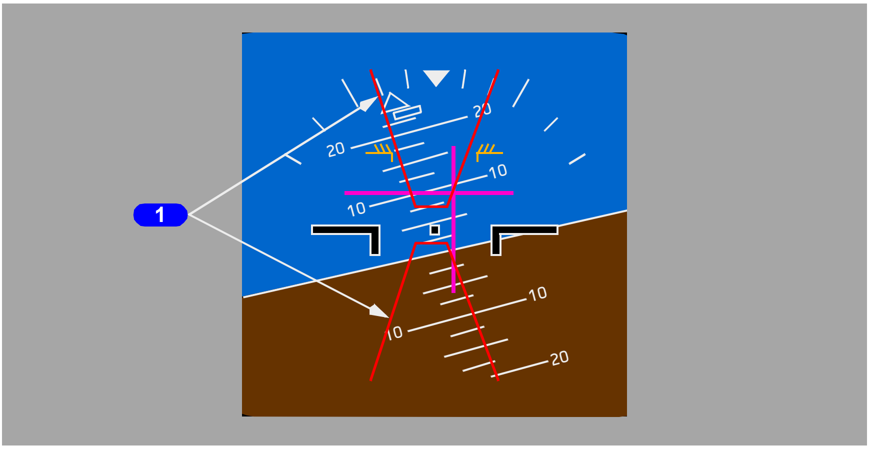
1 Rising Runway (green with magenta stem)

Displayed when:

- localizer signal usable or IAN approach selected and pointer is in view
- radio altitude is less than 2500 feet.

Rises towards airplane symbol when radio altitude is below 200 feet.

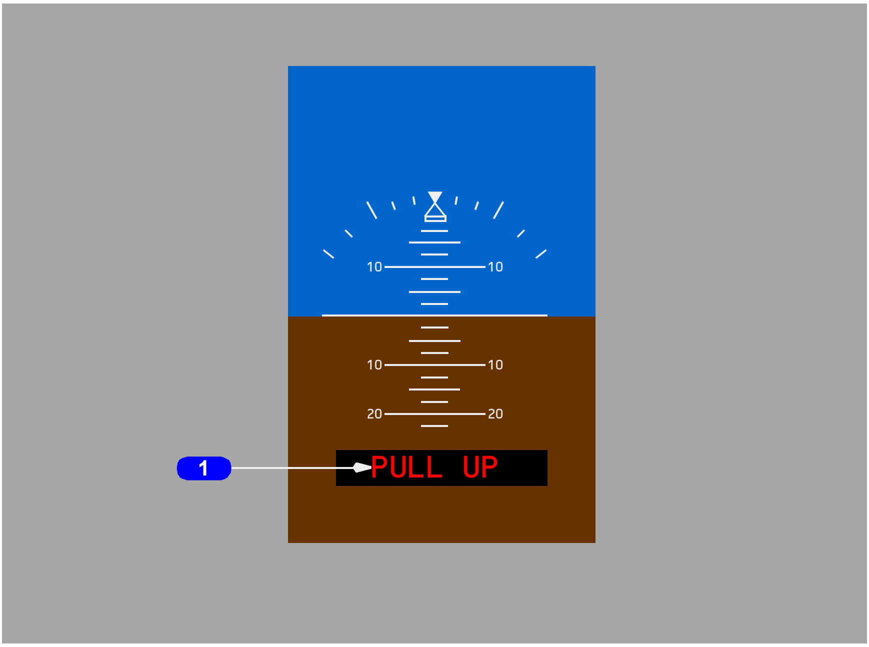
Traffic Alert and Collision Avoidance Indications



1 Traffic Alert and Collision Avoidance System Pitch Command (red)

The area(s) inside the red lines indicate(s) the pitch region(s) to avoid in order to resolve the traffic conflict. The airplane symbol must be outside the TCAS pitch command area(s) to ensure traffic avoidance. Refer to Chapter 15, Warning Systems.

GPWS Annunciations

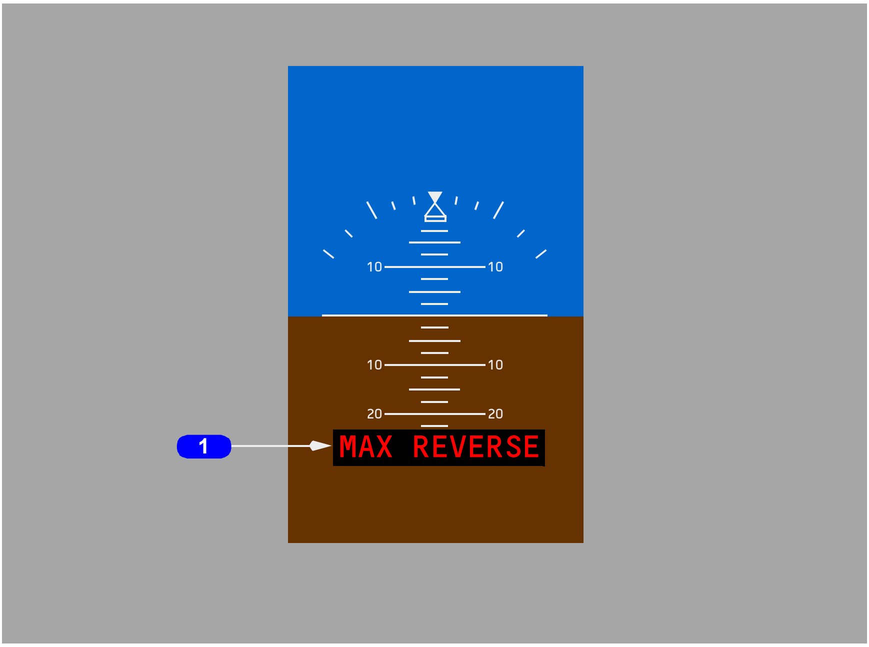


1 GPWS Annunciations (red)

Displays WINDSHEAR or Pull UP alert.

Refer to Chapter 15, Warning Systems.

On-Ground Overrun Warning
(as installed)

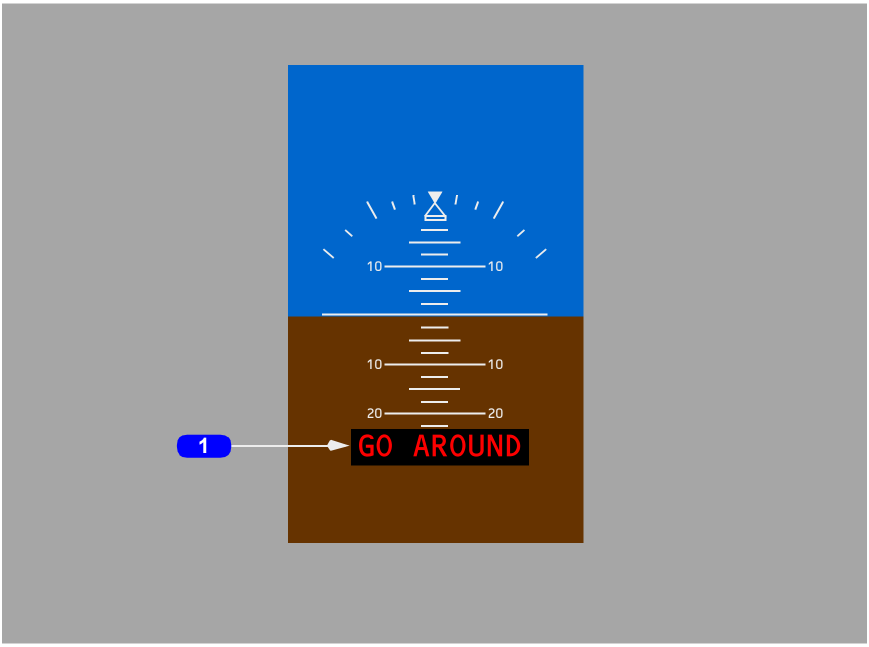


1 On-Ground Overrun Warning

The On-Ground Overrun Warning provides an alert when a runway overrun condition is likely to occur. The warning is armed from 3 seconds after touchdown until the airplane slows below 20 knots groundspeed or comes within 1000 feet of the end of the runway.

Refer to Chapter 15, Warning Systems.

In-Air Overrun Warning

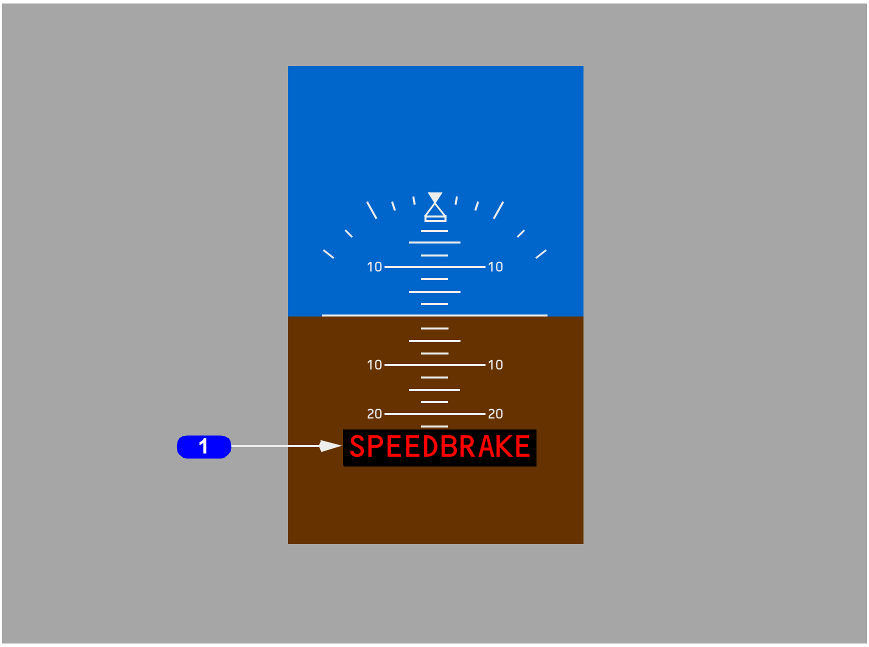


1 In-Air Overrun Warning

The In-Air Overrun Warning provides an alert when a runway overrun condition is likely to occur. The warning is armed from 500 feet above TDZE until touchdown.

Refer to Chapter 15, Warning Systems.

SPEEDBRAKE Warning
(as installed)



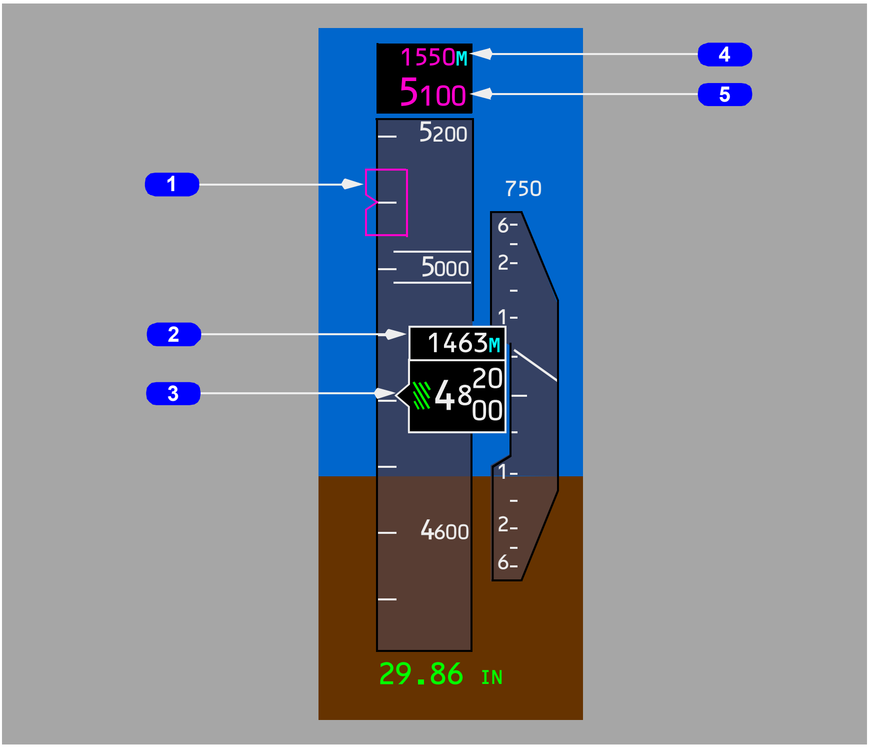
1 SPEEDBRAKE Warning (red)

The SPEEDBRAKE warning provides an alert when speedbrakes are not deployed during a landing or rejected takeoff. The alert activates when spoiler panels 4 and 9 are not at least halfway up by 3 seconds after touchdown or start of an RTO.

Refer to Chapter 15, Warning Systems.

PFD – Altitude Indications
Altitude Indications– General

The altitude indication displays ADIRS altitude and other altitude related information.



1 Selected Altitude Bug

Indicates the altitude set in the MCP altitude window.

When the selected altitude is off scale, the bug is parked at the top or bottom of the tape, with only one half the bug visible.

2 Metric Digital Readout (readout and box–white, metric symbol–cyan)

Displays current altitude in meters when MTRS is selected on the EFIS control panel.

3 Current Altitude

Displays current altitude in increments of thousands, hundreds and twenty feet:

- for positive values of altitude below 10,000 feet, a green crosshatch symbol is displayed
- a negative sign appears when altitude below zero feet is displayed
- readout box becomes bold to denote altitude acquisition
- readout box is highlighted in amber and flashes to denote altitude deviation (refer to Chapter 4, Automatic Flight and Chapter 15, Warning Systems).

4 Metric Selected Altitude Readout (readout–magenta, metric symbol–cyan)

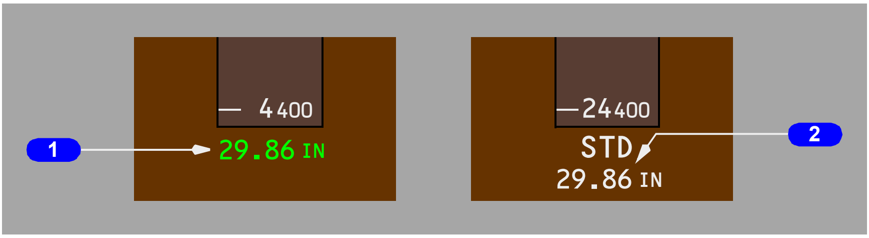
Displays MCP altitude in meters when MTRS is selected on the EFIS control panel.

5 Selected Altitude (magenta)

Displays the altitude set in the MCP altitude window.

The selected altitude box appears in white during an altitude alert. For more information, refer to Chapter 15, Warning Systems.

Barometric Indications



1 Barometric Settings (green)

Indicates the barometric setting in either inches of mercury (IN) or hectopascals (HPA) as selected on the EFIS control panel.

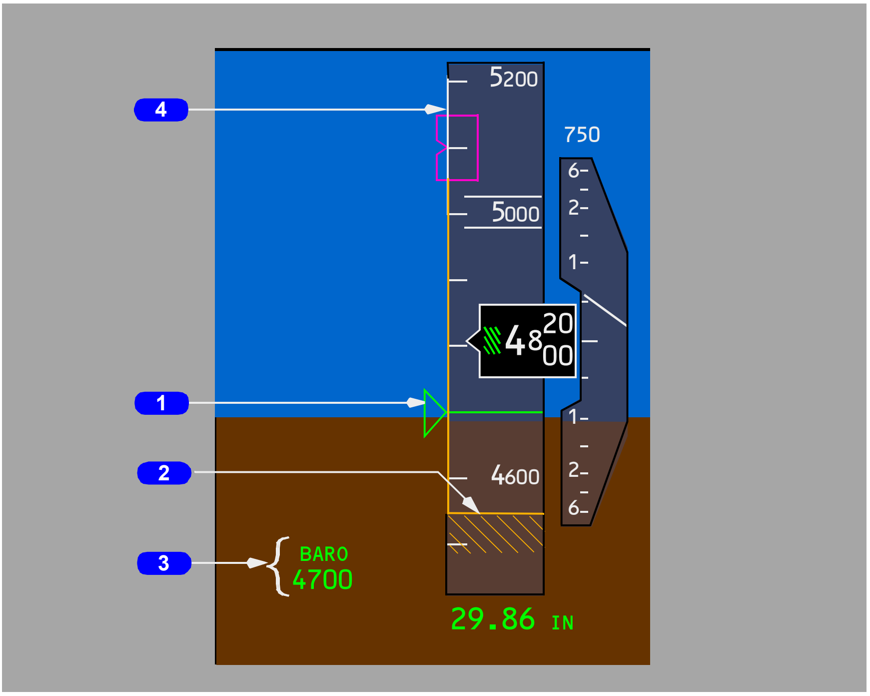
Display is boxed amber if numeric is set and airplane is climbing above transition altitude, or if STD is set and descending below transition flight level.

2 Preselected Barometric Setting (white)

STD is displayed when the Barometric Standard (STD) switch is selected on the EFIS control panel.

When STD is displayed, a barometric setting can be preselected on the EFIS control panel barometric selector and is displayed in small white characters below STD.

Landing Altitude/Minimums Indications



1 BARO Minimums Pointer (green)

Indicates the barometric minimums selected on the EFIS control panel:

- pointer and line turn amber when airplane descends below selected minimum altitude
- reset with the RST switch on the EFIS control panel.

After the pointer is set with the BARO position, moving the Minimums Reference selector to RADIO displays Radio Minimums information, but allows the Baro Pointer to remain.

2 Landing Altitude Indication (amber)

The crosshatched area indicates:

- the FMC landing altitude for the destination runway or airport, or
- the landing altitude for departure runway or airport until 400 NM from departure or one-half the distance to destination, whichever occurs first.

3 Minimums Reference/Altitude (green)

Displays approach minimum reference and altitude set by the MINS selector on the EFIS control panel:

BARO –

- displayed when selector is set to BARO, minimums are in feet MSL
- turns amber and flashes for 3 seconds when airplane descends below selected minimum altitude
- changes back to green:
  - when passing the selected minimum altitude plus 75 feet during go–around
  - at touchdown
  - after pressing the RST switch on the EFIS control panel.

RADIO –

- displayed when selector is set to RADIO, minimums are in feet AGL
- blank when an altitude less than 0 feet is selected
- turns amber and flashes for 3 seconds when airplane descends below selected minimum altitude
- changes back to green:
  - when passing the selected minimum altitude plus 75 feet during go–around
  - at touchdown
  - after pressing the RST switch on the EFIS control panel.

4 Landing Altitude Reference Bar

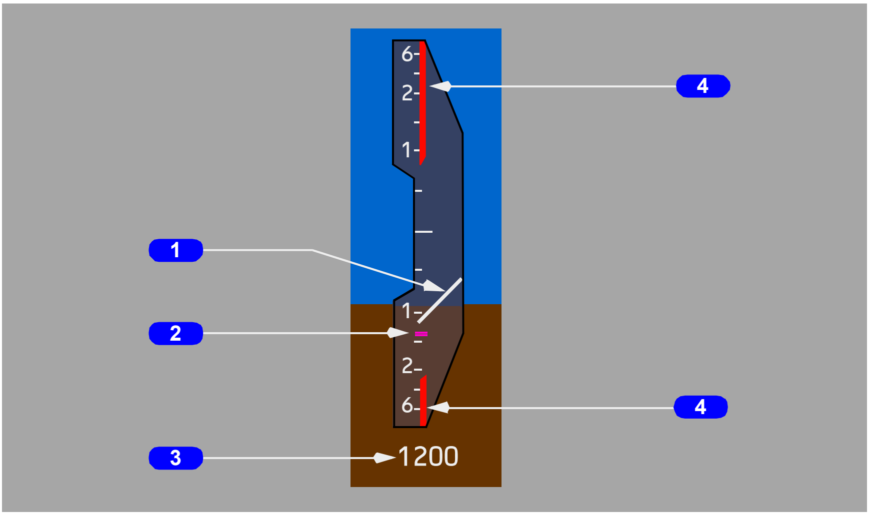
Indicates height above touchdown:

- White bar – 500 to 1000 feet above landing altitude
- Amber bar – 0 to 500 feet above landing altitude.

PFD – Vertical Speed Indications

Vertical Speed Indications – General

The vertical speed indication displays ADIRS instantaneous vertical speed.



1 Vertical Speed Pointer (white)

Indicates current vertical speed.

2 Selected Vertical speed Bug (magenta)

Indicates the speed selected in the MCP vertical speed window with V/S pitch mode engaged.

3 Vertical speed (white)

Displays vertical speed when greater than 400 feet per minute.

The display is located above the vertical speed indication when climbing and below when descending.

4 TCAS Vertical Speed Tape (red)

Tape turns red to indicate vertical speed values to avoid or exit during a TCAS resolution advisory.

Vertical speed pointer is red if it is within the vertical speed tape range.

Supplements TCAS resolution advisory pitch commands on the attitude indication.

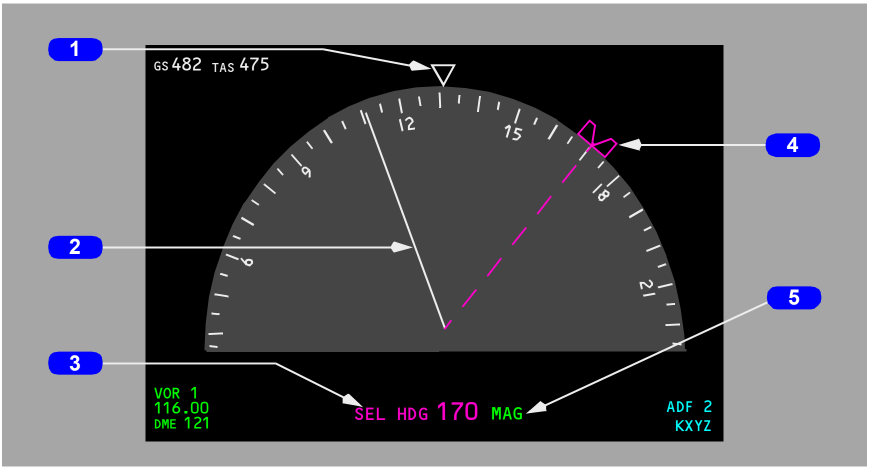
PFD Compass Card and Part-Time Mini-Map Display

VOR and ADF pointers are always displayed on the compass and part-time mini-MAP when selected for display through the EFIS CP. The VOR and or ADF needles allow for basic navigation if there should only be a single functioning DU.

Beneath the PFD is the compass and part-time mini-MAP where heading/track information is displayed. The PFD compass card has a gray shade and is always HDG-UP referenced. The selected heading readout (SEL HDG followed by the heading value and MAG/TRK) is shown at the bottom of the compass area.

When the Display Select Switches are in the Outboard or Inboard positions the PFD and AUX go into a half-screen format. In this configuration, the compass remains as a compass and will not become a back-up mini-map.

Compass Card



1 Current Heading Pointer (white)

Indicates current heading.

2 Track Pointer (white)

Indicates current track.

3 Selected Heading (magenta)

Digital display of the selected heading bug.

4 Selected Heading Bug (magenta)

Indicates the heading selected on the mode control panel. If the selected heading exceeds the display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the heading.

5 Magnetic/True Heading Annunciation (green)

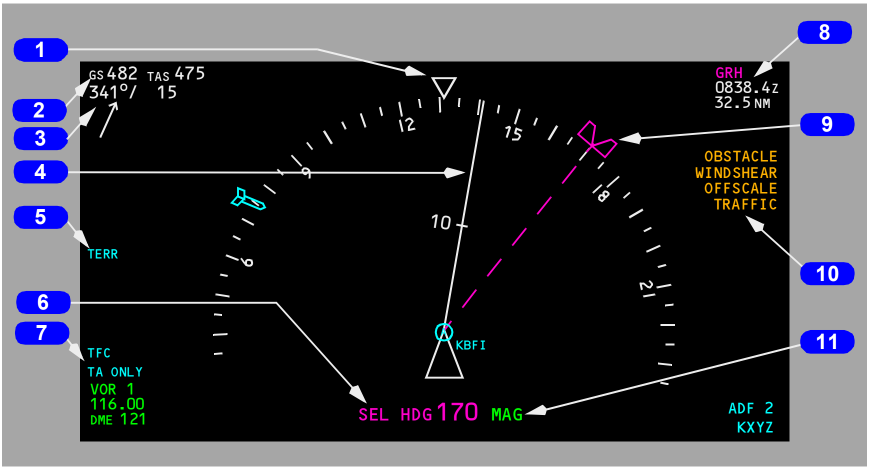
Displays selected heading reference:

- MAG indicates display is oriented relative to magnetic north
- TRU indicates display is oriented relative to true north; a white box is displayed continuously around TRU
- transition from TRU to MAG results in a green box around MAG for 10 seconds
- when TRU is displayed and the airplane descends more than 2000 feet at a descent rate greater than – 800 feet per minute, an amber box is drawn around TRU; the box flashes for 10 seconds, then turns steady amber.

Part-Time Mini-Map Display

The large display units allow for the compass rose to become a part-time mini-MAP. The part-time mini-MAP is only available when the normal PFD and AUX are displayed and the onside ND is not displayed due to an inboard display failure.

The part-time mini-MAP, a condensed version of the ND MAP is at a fixed 20 nm range and is meant to be a short-term navigational display which allows the pilots to see their relationship to the flight plan and potential threats ahead. TCAS targets and terrain/weather can be displayed on the mini-MAP. Terrain, TCAS and Predictive Windshear alerts are annunciated on the mini-MAP. True Airspeed (TAS), Ground Speed (GS), Wind Direction, and Wind Speed are also shown.



1 **Current Heading Pointer (white)**

Indicates current heading.

2 **Groundspeed/True Airspeed (white)**

Indicates current groundspeed and true airspeed.

3 **Wind Direction/Speed/Arrow (magenta)**

Indicates current wind direction and wind speed

4 **Track Pointer (white)**

Indicates current track.

5 **Terrain/Weather Radar Annunciations (cyan)**

Annunciates TERR is selected and displays associated Peaks Mode data.

Annunciates WXR is selected and associated WXR mode, tilt and gain settings.

6 Selected Heading (magenta)

Digital display of the selected heading bug.

7 TCAS Selection (cyan)

Indicates selection and alerting mode of TCAS.

8 Active Waypoint/ETA/Distance–To–Go (magenta/white)

Displays active waypoint, distance to go, and estimated time of arrival.

9 Selected Heading Bug (magenta)

Indicates the heading selected on the mode control panel. If the selected heading exceeds the display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the heading.

10 Terrain/Obstacle/Windshear/Traffic Alerts (amber)

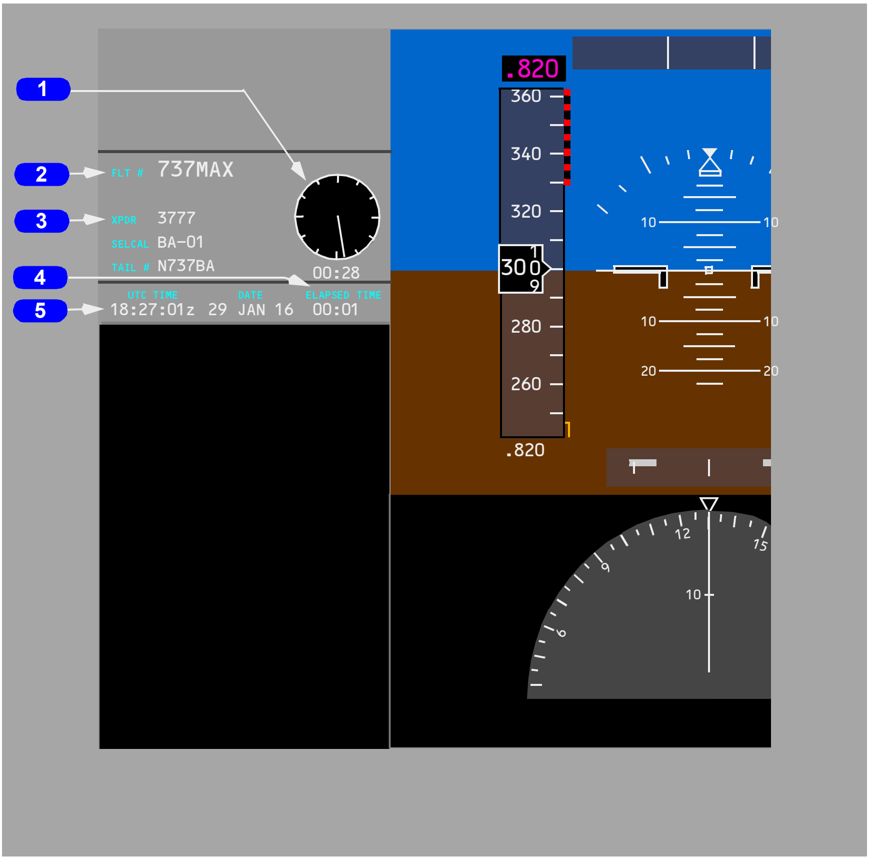
Annunciates Alerts from the Enhanced Ground Proximity Warning System, Predictive Windshear System, and Traffic Collision Avoidance System.

11 Magnetic/True Heading Annunciation (green)

Displays selected heading reference:

- MAG indicates display is oriented relative to magnetic north
- TRU indicates display is oriented relative to true north; a white box is displayed continuously around TRU
- transition from TRU to MAG results in a green box around MAG for 10 seconds
- when TRU is displayed and the airplane descends more than 2000 feet at a descent rate greater than – 800 feet per minute, an amber box is drawn around TRU; the box flashes for 10 seconds, then turns steady amber.

AUX Display



1 Chrono Dial and Readout

Major tick marks are placed at 0, 15, 30 and 45 seconds and minor tick marks are placed at 5, 10, 20, 25, 35, 40, 50 and 55 seconds.

2 Flight Number

Flight number readout is received from the FMC or COMM Manager function. If the FMC/COMM Manager functions are blank, the readout will display "----------".

3 Transponder Code

Active transponder code entered by the pilot on the transponder panel.

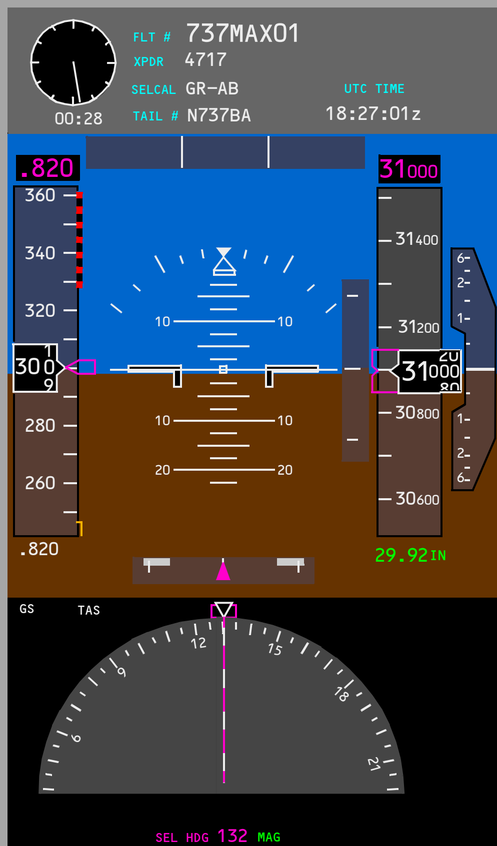
4 **Elapsed Time**

Starts at weight off wheels, stops 30 seconds after weight on wheels and resets on power up or new origin airport RUNWAY is entered on the FMC route page.

5 **UTC Time**

PFD Reversion Mode

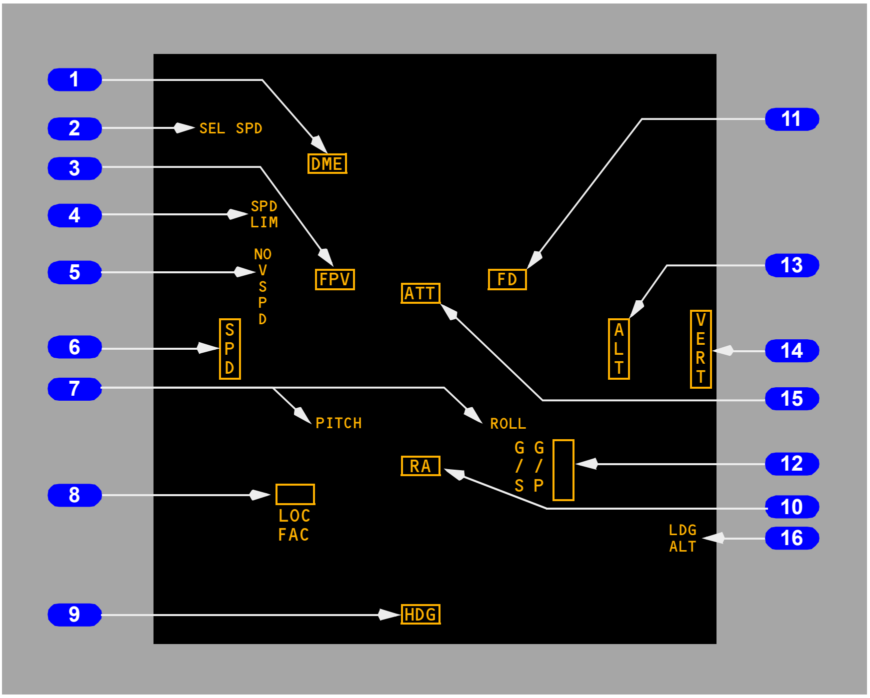
The PFD is shown in reversion mode for some display failures. The PFD is cropped to fit within an MFD window (one half of a Display Unit). All PFD symbology remains in the same relative position referenced to the airplane symbol center.

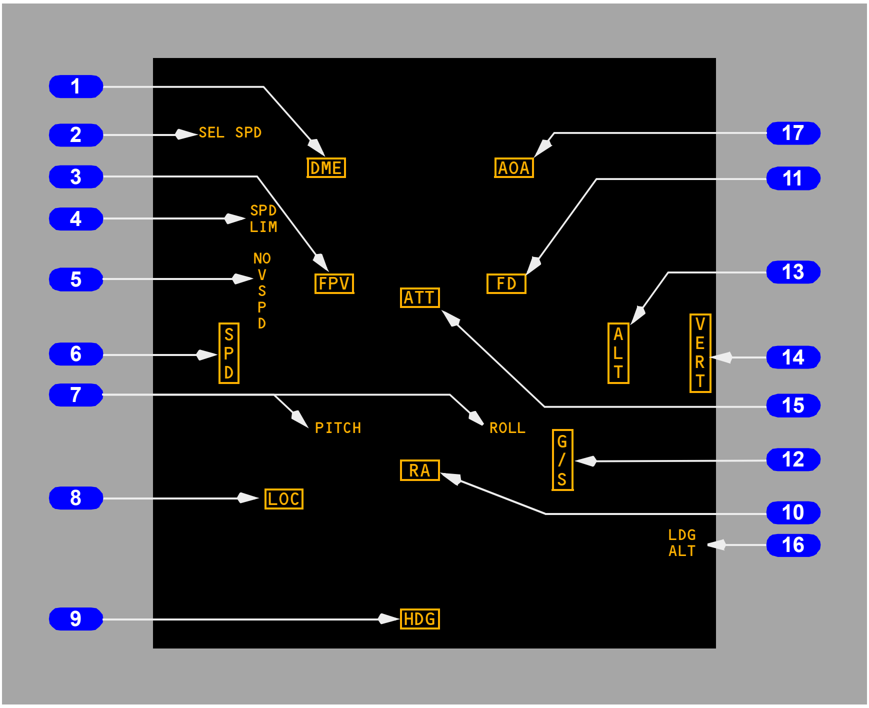


FIRST OFFICER DISPLAY

PFD Failure Flags

The flag replaces the appropriate display to indicate system failure.





1 Distance Measuring Equipment (amber)

The DME system has failed.

2 Selected Speed (amber)

The selected airspeed data is invalid.

3 Flight Path Vector Flag (amber)

FPV is selected on the EFIS control panel, but has failed. De–selection of FPV removes the flag.

4 Speed Limit Flag (amber)

Displays related with stick shaker or maximum operating speed has failed:

- if the stick shaker warning has failed, the red and black stick shaker speed bar is removed
- if the maximum operating speed has failed, the red and black maximum operating speed bar is removed.

5 No V Speeds Flag (amber)

Displayed when the aircraft is on the ground and both V1 (decision speed) and VR (rotation speed) are not valid or are set to less than 80 knots.

6 Speed Flag (amber)

Speed indication is inoperative.

7 Pitch/Roll Comparator Annunciation (amber)

PITCH displayed when Captain's and F/O's pitch angle displays differ by more than 5 degrees.

ROLL displayed when Captain's and F/O's roll angle displays differ by more than 5 degrees.

The flags flash for 10 seconds then remain steady.

8 Localizer Flag (amber)

An ILS frequency is tuned and localizer course indication has failed.

8 Localizer/FAC Flag (amber)

An ILS frequency is tuned and localizer course indication has failed. An IAN approach is active and FAC indication has failed.

9 Heading Flag (amber)

Heading information failed. Heading cannot be displayed.

10 Radio Altitude Flag (amber)

Radio altitude indication has failed.

11 Flight Director Flag (amber)

The flight director has failed.

12 Glideslope Flag (amber)

An ILS frequency is tuned and glideslope indication has failed.

12 Glideslope/Glide Path Flag (amber)

An ILS frequency is tuned and glideslope indication has failed. An IAN approach is active and glide path indication has failed.

13 Altitude Flag (amber)

The altitude display has failed.

14 Vertical Speed Flag (amber)

Vertical speed has failed.

15 **Attitude Flag (amber)**

The attitude display has failed.

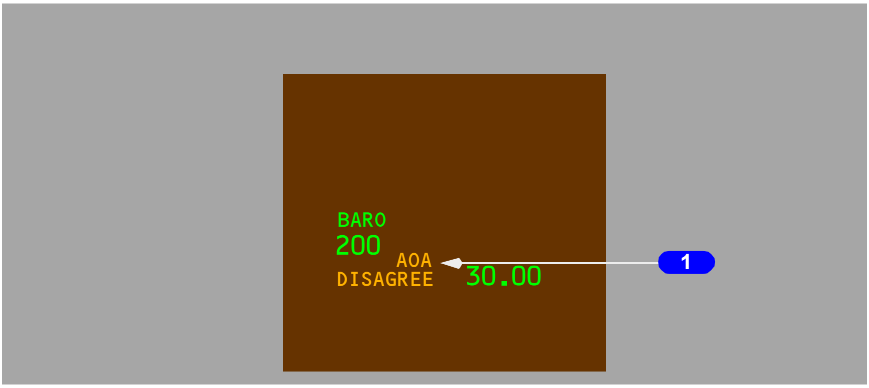
16 **Landing Altitude Flag (amber)**

The landing altitude input is not available or invalid.

17 **Angle of Attack (amber)**

The AOA signal has failed or is invalid when ground speed is greater than 80 knots.

PFD Annunciations and Alerts
Angle of Attack (AOA) Disagree Alert



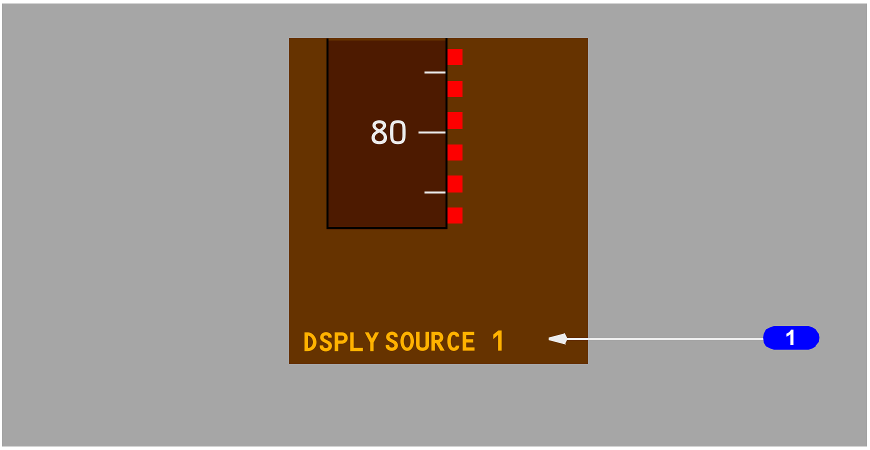
1 **AOA DISAGREE Alert (amber)**

Indicates the Captain’s (left) and First Officer’s (right) AOA values disagree by greater than 10 degrees for more than 10 seconds. The alert is shown on both PFDs and does not indicate which AOA value is erroneous.

The AOA DISAGREE alert logic is active when the airplane is above 400 feet RA.

NOTE: If the AOA DISAGREE alert is shown when descending through 400 feet RA, the alert remains until landing.

Display System Alerts



1 Display System Alerts

When there is a problem with the DPC display system, one of the following indications will appear in the lower left corner of the primary flight display:

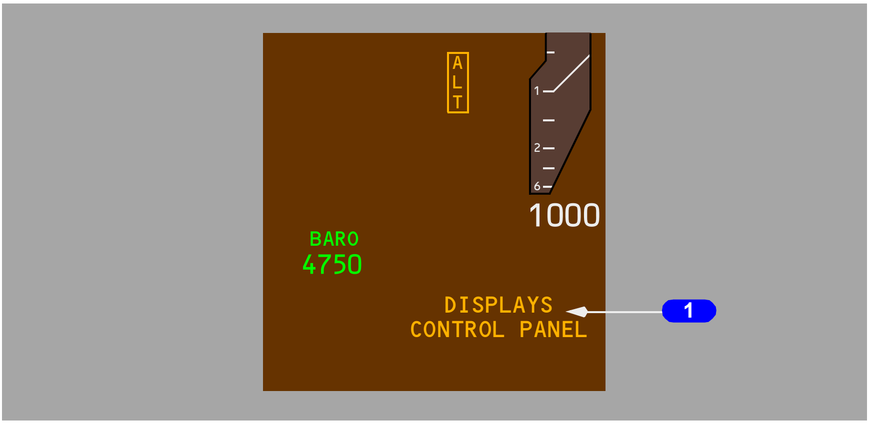
DSPLY SOURCE 1 or 2 (amber) – DPC 1 has failed or DPC 2 has failed.

Split axis flight director –

- If a DPC fails above FL220 –
  - the autopilot and flight directors are not affected
- If a DPC fails during climb or descent below FL220 with the failed side autopilot engaged –
  - the flight director pitch command bar is removed from both pilot's displays
  - the flight director pitch command bars reappears at ALT ACQ
  - the autopilot engages in CWS P
  - LVL CHG, VNAV, and V/S are not available with the failed side autopilot
- If a DPC fails during level flight below FL220 with the failed side autopilot engaged –
  - climb or descent to a new altitude is only possible in CWS P
  - initial climb or descent from a new MCP altitude is not possible in LVL CHG, VNAV or V/S modes with the autopilot engaged

- If the DPC fails on the opposite side as the engaged autopilot or while in manual F/D mode during climb or descent–
  - •the flight director pitch command bar is removed from the pilot's display on the failed side until ALT ACQ
  - •climb or descent is possible in LVL CHG, VNAV or V/S modes with the autopilot engaged.
- If a DPC fails in the approach mode above 400 feet with both flight directors on –
  - •the flight director pitch and roll command bars are removed from the display on the failed side
- If a DPC fails prior to engaging the second autopilot for a dual autopilot approach –
  - •engagement of the second autopilot is inhibited.

Displays Control Panel Annunciation (EFIS CP)



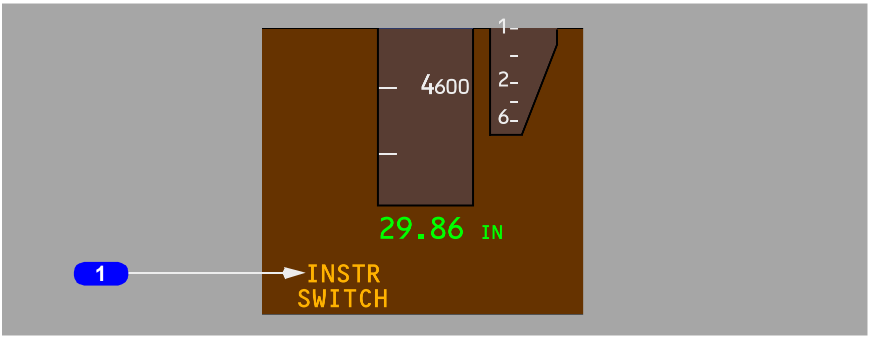
1 Displays Control Panel Annunciation (amber)

Indicates a failed EFIS control panel on the affected side. When DISPLAYS CONTROL PANEL appears in the lower right hand corner of the display, altitude information is removed.

With the CONTROL PANEL select switch on the overhead panel in:

- BOTH ON 1 – Both the Captain's and First Officer's displays and baro are controlled from the left EFIS panel
- NORMAL – Left EFIS panel controls Captain's displays and baro, Right EFIS panel controls First Officer's displays and baro.
- BOTH ON 2 – Both the Captain's and First Officer's displays and baro are controlled from the right EFIS panel.

Instrument Switch Annunciation

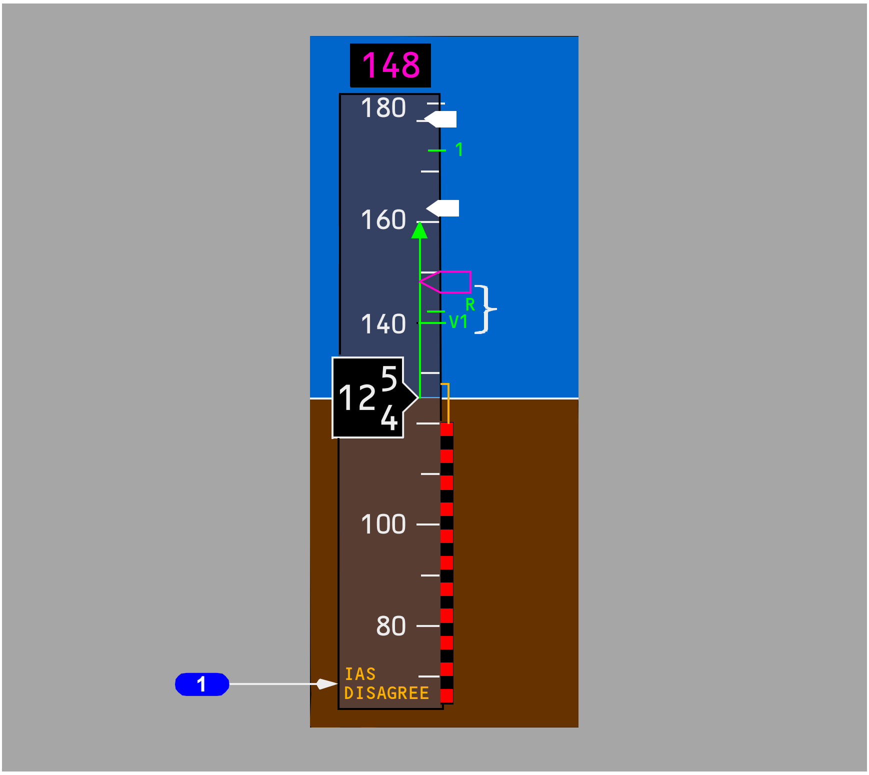


1 INSTR SWITCH Annunciation (amber)

Indicates both the Captain's and First Officer's displays are using the same source of IRU data.

Displayed when the IRS switch on the overhead panel is not in the NORMAL position. See Chapter 11, Section 10, for Inertial Reference System Transfer Switch information.

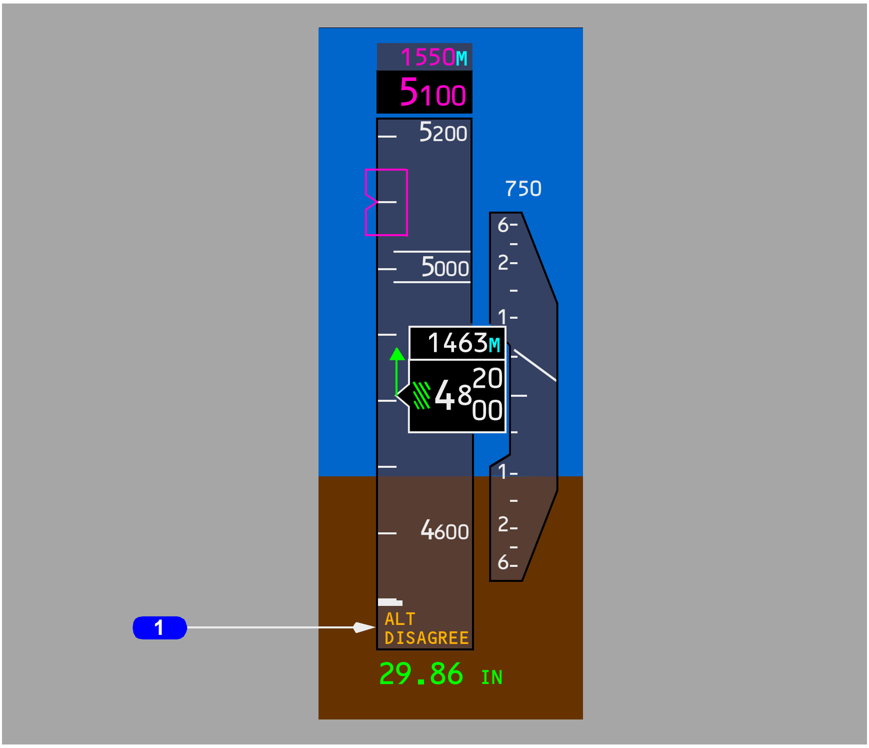
Airspeed Disagree Alert



1 IAS DISAGREE Alert (amber)

Indicates the Captain's (left) and First Officer's (right) airspeed values disagree by greater than 5 knots for more than 5 seconds. The alert is shown on both PFDs and does not indicate which airspeed value is erroneous.

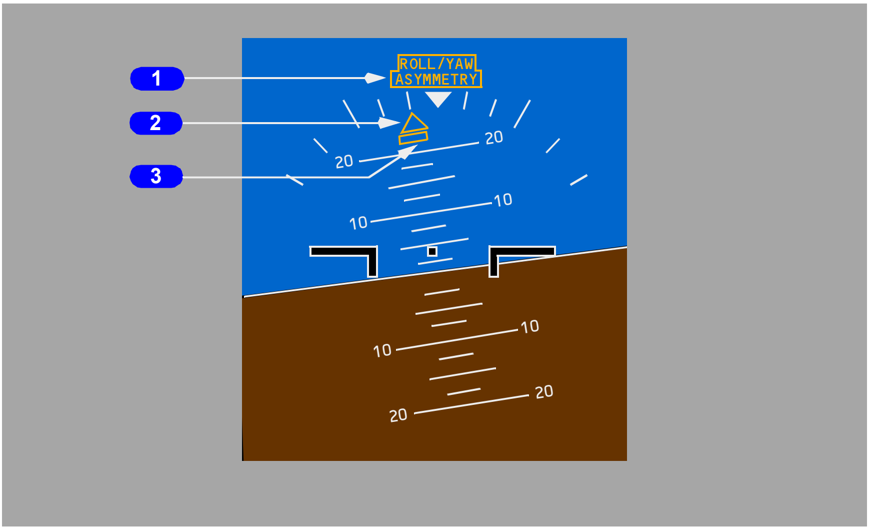
Altitude Disagree Alert



1 ALT DISAGREE Alert (amber)

Indicates the Captain’s (left) and First Officer’s (right) altitude values disagree by greater than 200 feet for more than 5 seconds. The alert is shown on both PFDs and does not indicate which altitude value is erroneous.

Roll/Yaw Asymmetry Alert



1 Roll/Yaw Asymmetry Alert (amber)

Autopilot is engaged in single channel and requires more than 75% of the autopilot roll authority due to unusual asymmetric forces acting on the airplane's longitudinal axis.

The ROLL/YAW ASYMMETRY alert:

- replaces the active autopilot status annunciation.
- is replaced with ROLL AUTHORITY when 100% of the autopilot roll authority is required.
- is replaced by the active autopilot status annunciation when less than 50% of the autopilot roll authority is required.

2 Bank Pointer (amber)

With ROLL/YAW ASYMMETRY alert active:

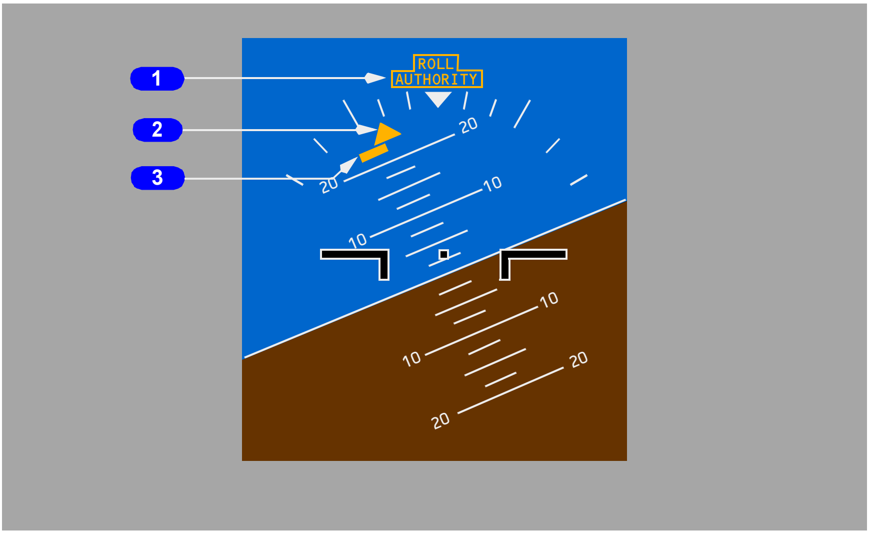
- bank pointer outline will turn amber.
- bank pointer will fill amber if bank angle exceeds 15 degrees.

3 Slip/Skid Indication (amber)

With ROLL/YAW ASYMMETRY alert active:

- slip/skid indication outline will turn amber.
- slip/skid indication will fill amber if deflected greater than 25% of its width,

Roll Authority Alert



1 Roll Authority Alert (amber)

Autopilot is engaged in single channel and requires 100% of the autopilot roll authority due to unusual asymmetric forces acting on the airplane's longitudinal axis.

The ROLL AUTHORITY alert:

- replaces the active autopilot status annunciation.
- is replaced by the active autopilot status annunciation when less than 100% of the autopilot roll authority is required.

2 Bank Pointer (amber)

With ROLL AUTHORITY alert active:

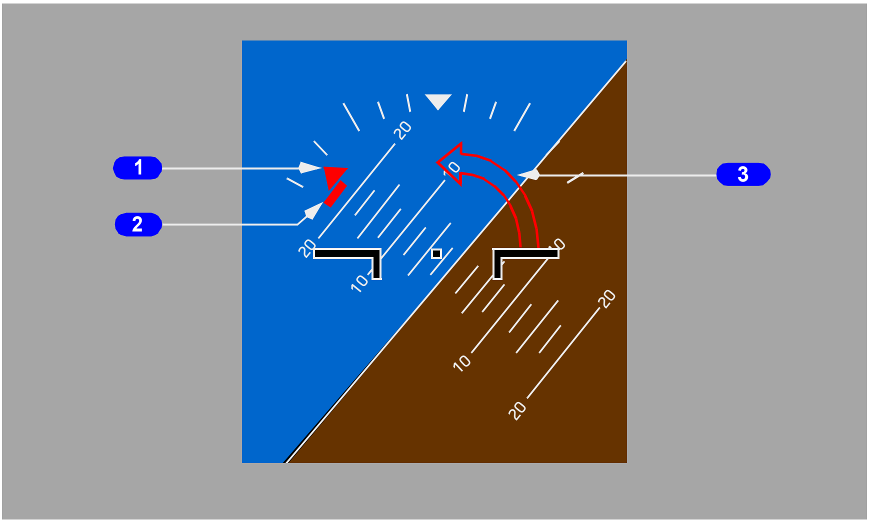
- bank pointer outline will turn amber.
- bank pointer will fill amber if bank angle exceeds 15 degrees.

3 Slip/Skid Indication (amber)

With ROLL AUTHORITY alert active:

- slip/skid indication outline will turn amber.
- slip/skid indication will fill amber if deflected greater than 25% of its width,

Roll Command Arrow



1 Bank Pointer (red)

When roll command arrow shown:

- bank pointer fills red.

2 Slip/Skid Indication (red)

When roll command arrow shown:

- slip/skid indication outline will turn red.
- slip/skid indication will fill red if it is deflected greater than 25% of its width.

3 Roll Command Arrow (red)

The roll command arrow points in the shortest direction to wings level. If the bank angle passes 180 degrees, the roll command arrow points in the new shortest direction to wings level. The roll command arrow is displayed with or without the autopilot engaged.

The roll command arrow is shown when bank angle exceeds:

- 45 degrees if the pitch attitude is 25 degrees or less.
- 65 degrees if the pitch attitude is greater than 25 degrees.

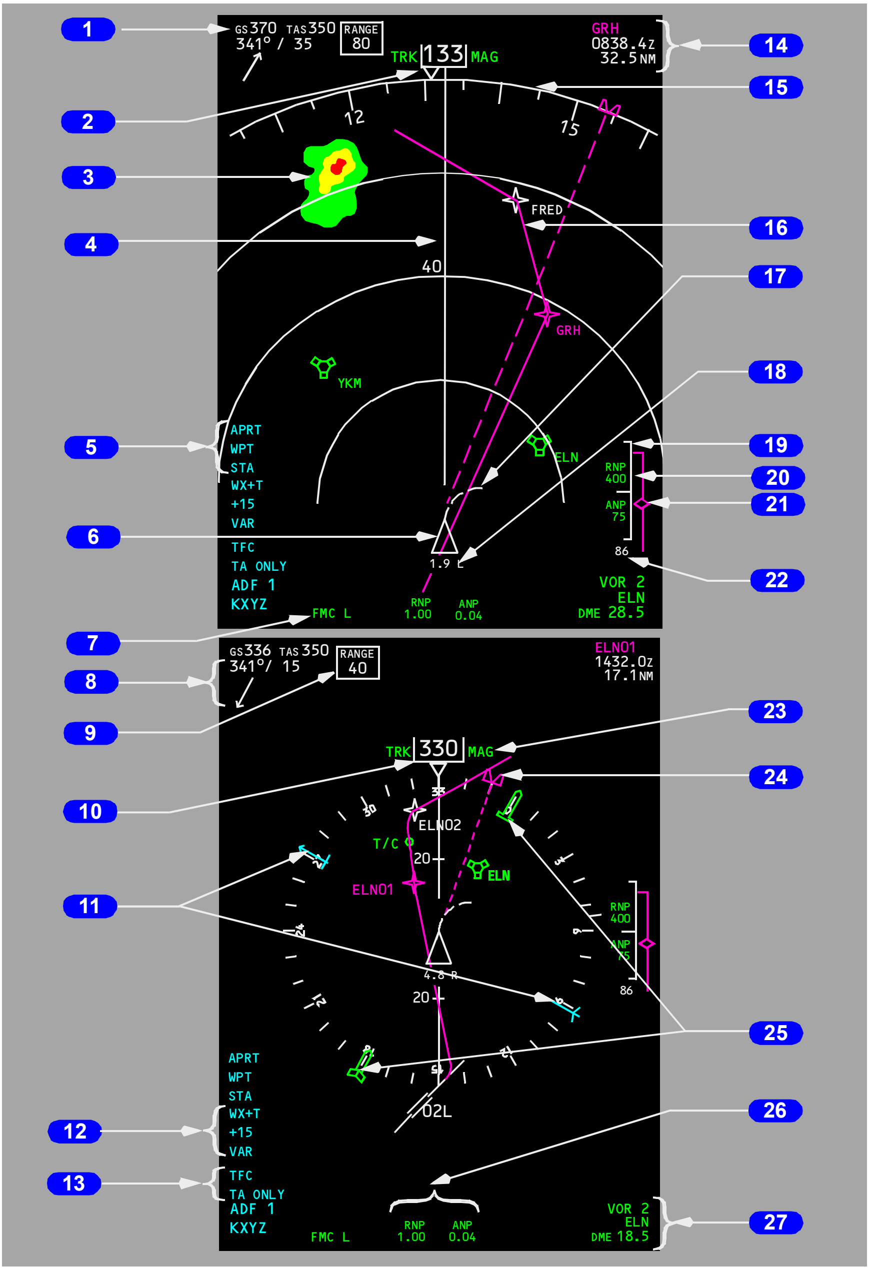
The roll command arrow is removed:

- when the bank angle is less than 35 degrees for 2 seconds, or;
- immediately if the bank angle is less than 10 degrees.

Navigation Displays – MAP Mode

Note: Refer to Section 40 of this chapter for a detailed explanation of the navigation symbology shown on the following pages.

Expanded and Center MAP Modes



1 **Groundspeed/True Airspeed**

2 **Heading Pointer**

3 **Weather Radar Returns**

4 **Track Line and Range Scale**

5 **Map Options**

6 **Airplane Symbol**

7 **Map Source Annunciation**

8 **Wind Direction/Speed/Arrow**

9 **ND Range**

10 **Current Track**

11 **Number 1 VOR/ADF Pointer**

12 **Weather Radar Annunciations**

13 **TCAS Selection**

14 **Active Waypoint/ETA/Distance–To–Go**

15 **Compass Rose**

16 **Active LNAV Route**

17 **Position Trend Vector**

18 **Cross-Track Error (NM)**

19 **VNAV Deviation Scale**

20 **VNAV Path Deviation Band**

21 **VNAV Path Pointer**

22 **Vertical Path Deviation**

23 **Magnetic/True Reference**

24 **Selected Heading Bug**

25 **Number 2 VOR Pointer**

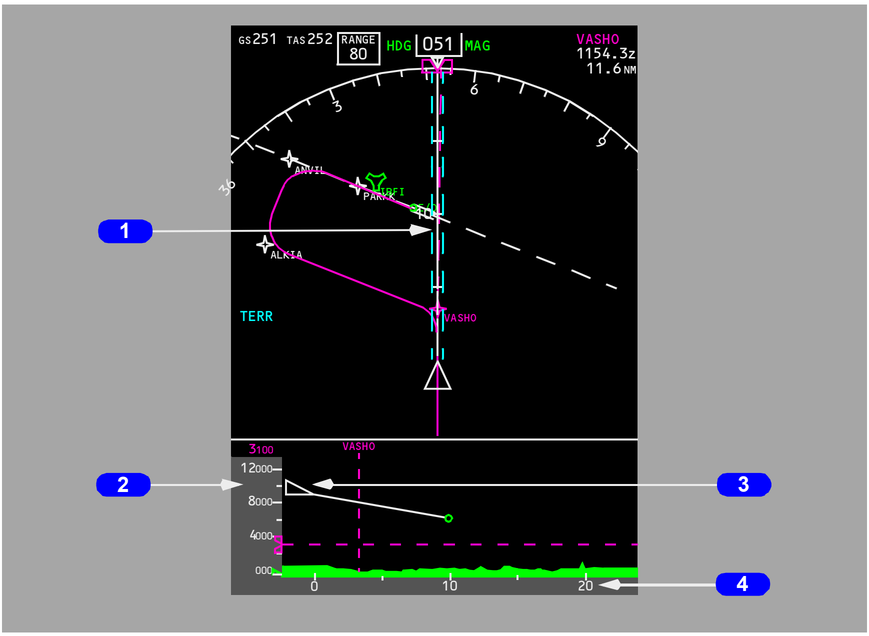
26 **Lateral RNP / ANP**

27 **VOR/ADF Selection, Ident/Frequency, VOR DME**

Vertical Situation Display (VSD)

The VSD represents a profile view of the airplane and its environment along the current track. Information shown within the cyan dashed lines (enroute corridor) on the ND is shown in profile on the VSD.

Vertical Situation Display (VSD) - Reference Scales



1 **Enroute Swath**

Indicates area mapped by the VSD.

2 **Altitude Reference Scale**

Displays altitude in reference to the vertical position of the airplane symbol, terrain, and other objects in the VSD background display.

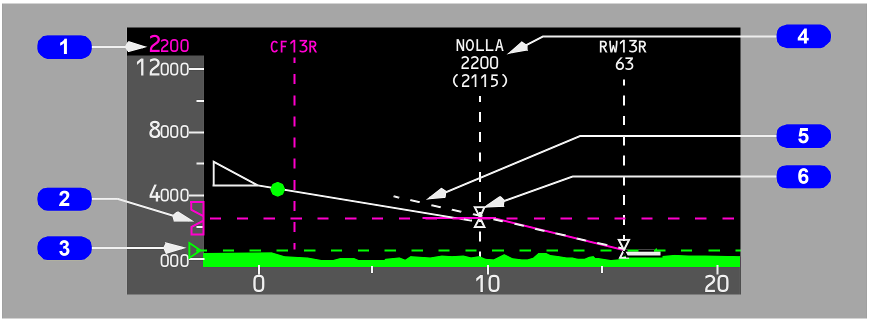
3 **Airplane Symbol**

Indicates current airplane altitude (bottom of the triangle) and lateral position (point of the triangle) relative to terrain.

4 Horizontal Reference Scale

The half-width VSD has the same range as the ND except when the selected ND range is less than 5NM, during which the half-width VSD range remains at 5NM. The full-width VSD has two times the range of the ND, ranging from 10NM to 1280NM. The full-width VSD range remains at 10NM when the ND range is below 5NM.

Vertical Situation Display (VSD) - General Background



1 MCP Selected Altitude Readout (magenta)

Displays the altitude set in the MCP altitude window.

2 Selected Altitude Bug (magenta)

Indicates the altitude set in the MCP altitude window.

When the selected altitude is off scale, the bug is parked at the top or bottom, with only one half the bug visible. The dashed line does not park.

3 BARO Minimums Pointer (green)

Indicates the barometric minimums selected on the EFIS control panel:

- pointer and dashed line turn amber when airplane descends below selected minimum altitude
- reset with the RST switch on the EFIS control panel.

After the pointer is set with the BARO position, moving the Minimums Reference selector to RADIO displays only the pointer.

4 Waypoint ID and Anchor Line (white)

Displayed with any altitude constraint directly beneath. Dashed vertical line depicts lateral position.

5 FMC Approach Glide Path Angle Line (white)

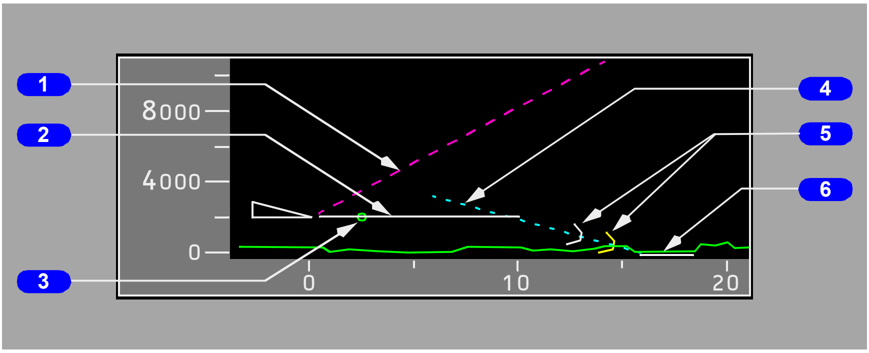
Displayed for approaches that include a designated approach angle.

- extends 10 NM for situational awareness
- anchored to the missed approach waypoint, not the runway.
- manual altitude corrections can change the displayed FMC glidepath if the manual altitude causes the FMC to calculate an angle that is greater than the navigation database defined angle.

6 **Altitude Constraint Symbol (white)**

Displayed as triangle(s) on waypoint anchor line.

Vertical Situation Display (VSD) - Flight Path Background



1 **MCP Selected Vertical Speed (V/S) (magenta)**

Displays the selected vertical speed as a dashed target angle line when the MCP V/S mode is selected.

2 **Vertical Flight Path Vector (white)**

Indicates current flight path angle as a function of vertical speed and ground speed. The length of the vector is fixed at: 2.5nm for ranges 5nm and below, and one half the ND range for ranges greater than 5nm.

3 **Range to Target Speed Dot (RTSD) (green)**

Indicates where the airplane will achieve the FMC or MCP target speed.

- dot is blanked within 5 knots of target speed
- dot appears if more than10 knots above target speed
- dot is unfilled and placed at the end of the vertical flight path vector line if the speed will not be achieved in the distance of the vertical flight path vector line
- dot is unfilled and placed at the edge of the display along the vertical flight path vector line if the speed will not be achieved within the display area.

4 **3-Degree Reference Line (cyan)**

Displayed for approaches that do not have a designated approach angle.

- dashed line extends 10 NM for situational awareness
- anchored to the runway threshold
- for reference only, line may intersect terrain.

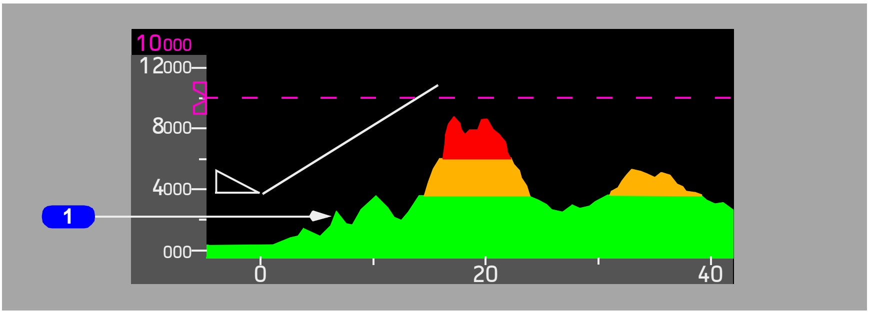
5 Decision Gates (white, amber)

Displayed on the FMC approach glide path angle line or 3 degree reference line at 500 feet and 1000 feet above field elevation.

6 Runway (white)

Represents the selected runway.

Vertical Situation Display (VSD) - Terrain Background



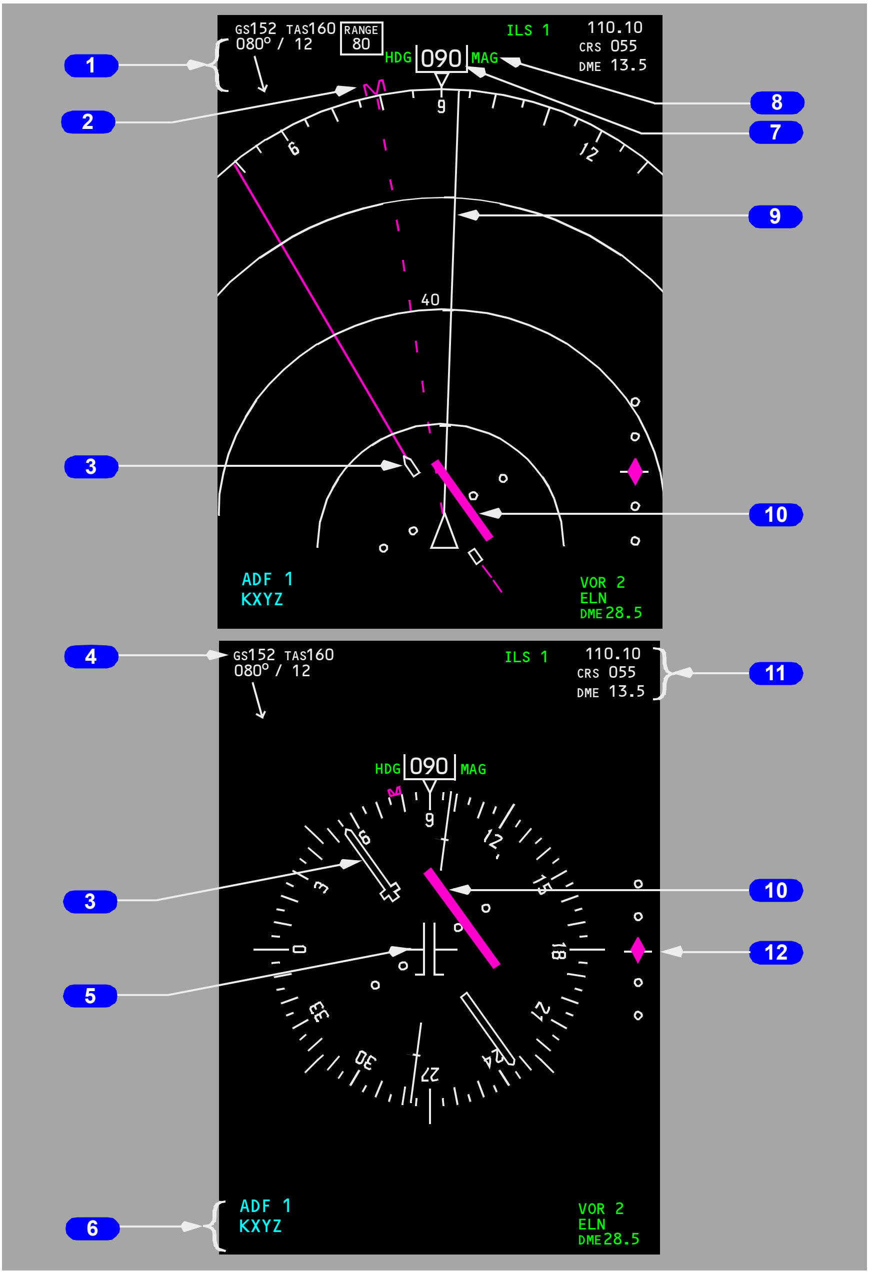
1 Terrain Profile Line

Represents the highest terrain within the enroute swath.

- highest points of the terrain below and ahead of the airplane
- terrain is depicted so the true altitude separation between the airplane and terrain is shown
- terrain behind the airplane is drawn equal to the terrain at the current position
- VSD terrain uses the same color coding that is used to depict EGPWS terrain on the lateral map –
- green: terrain is more than 500 feet (250 feet gear down) below the airplane
- amber: terrain ranges from 500 feet below (250 feet gear down) to 2000 feet above the airplane
- red: terrain is 2000 feet above the airplane.

Note: See Chapter 15, Section 10, for Terrain Warnings.

Navigation Displays – Approach Mode
Expanded and Center Approach Modes



1 Wind Direction/Speed/Arrow

2 Selected Heading Bug

3 Selected Course Pointer

4 Groundspeed/True Airspeed

5 Airplane symbol

6 VOR/ADF Selection/Ident or Frequency/VOR DME

7 Current Heading

8 Magnetic/True Reference

9 Track Line

10 Localizer Deviation Indication and Scale

11 Upper Corner Approach Information

For ILS:

- ILS Receiver, and Identification or Frequency/Course/DME

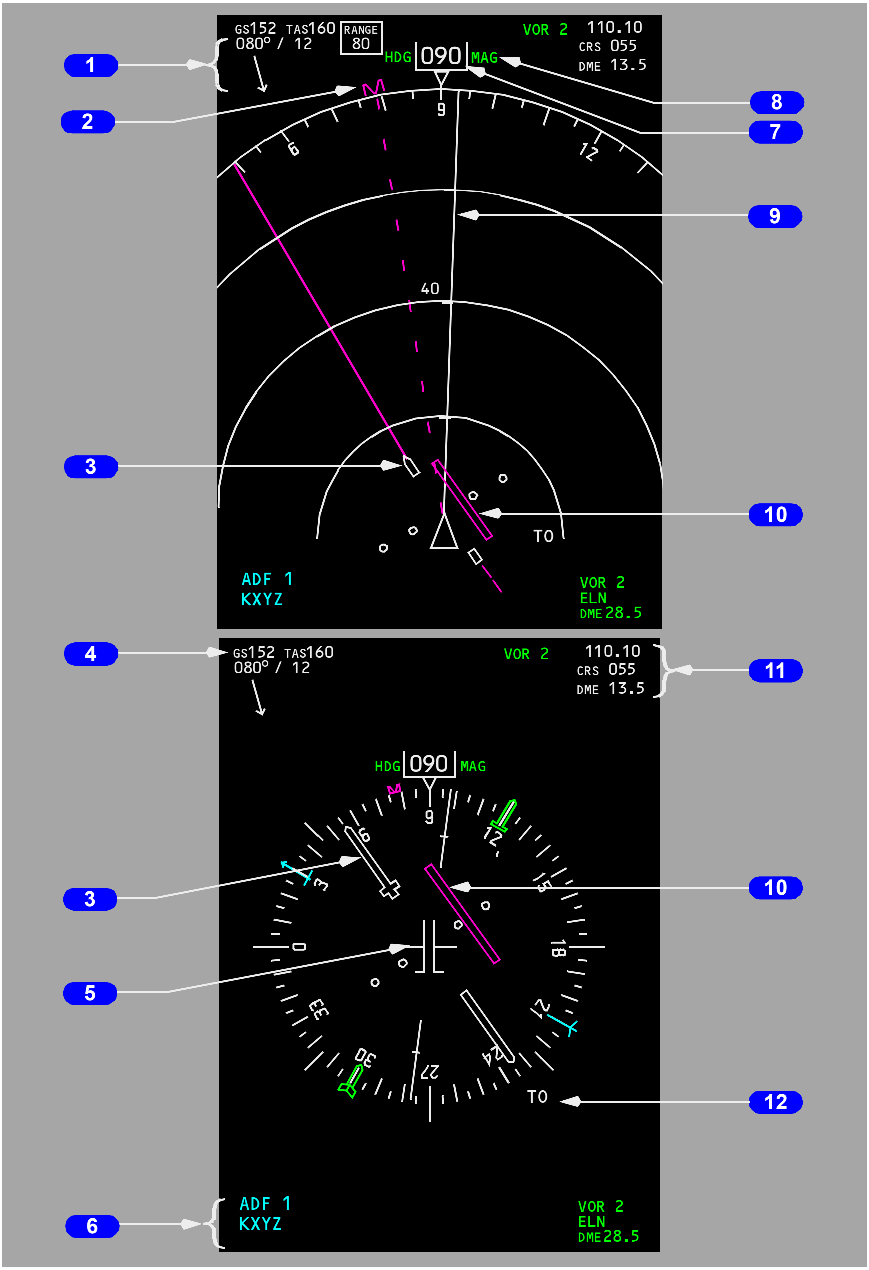
For GLS:

- GLS Receiver, and Identification or Channel/Course/GLS Runway and Referenced Distance.

12 Glideslope Pointer and Scale

Navigation Displays – VOR Mode

Expanded and Center VOR Modes



1 **Wind Direction/Speed/Arrow**

2 **Selected Heading Bug**

3 **Selected Course Pointer**

4 **Groundspeed/True Airspeed**

5 **Airplane symbol**

6 **VOR/ADF Selection/Ident or Frequency/VOR DME**

7 **Current Heading**

8 **Magnetic/True Reference**

9 **Track Line**

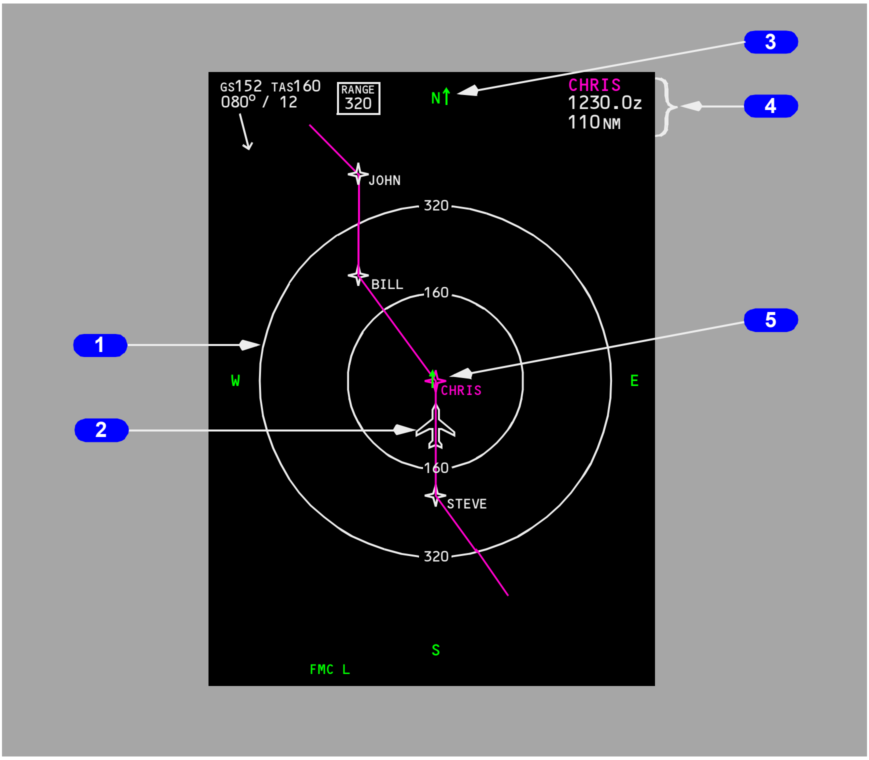
10 **Course Deviation Indication and Scale**

11 **Reference VOR Receiver/Frequency or Ident/Course/DME**

12 **TO/FROM Indication and TO pointer**

Navigation Displays – Plan Mode

Plan Mode



1 Range Circle

2 Airplane Symbol

3 True North Up Arrow

4 Active Waypoint Information

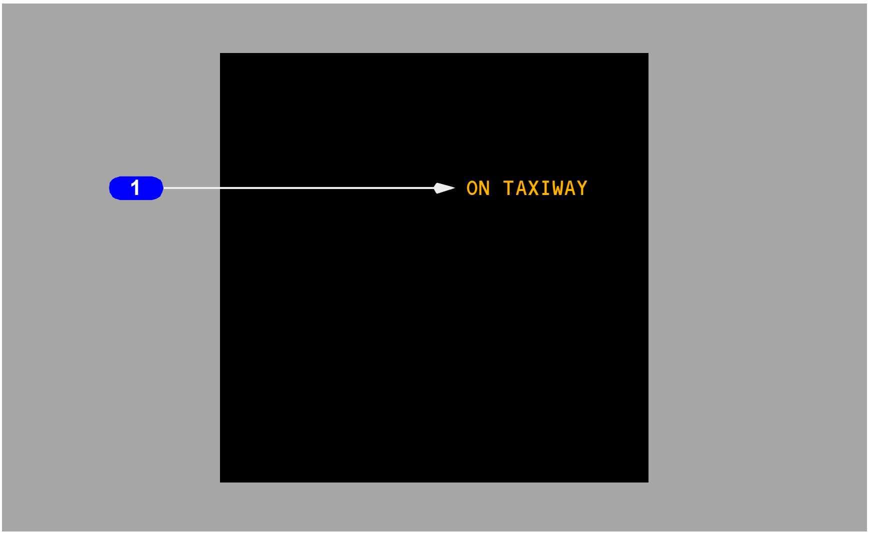
5 Center Waypoint

The waypoint located at the display center is identified as CTR on the CDU RTE LEGS page.

Navigation Displays – Alerts

Runway Awareness and Advisory System Alerts (RAAS)

(as installed)

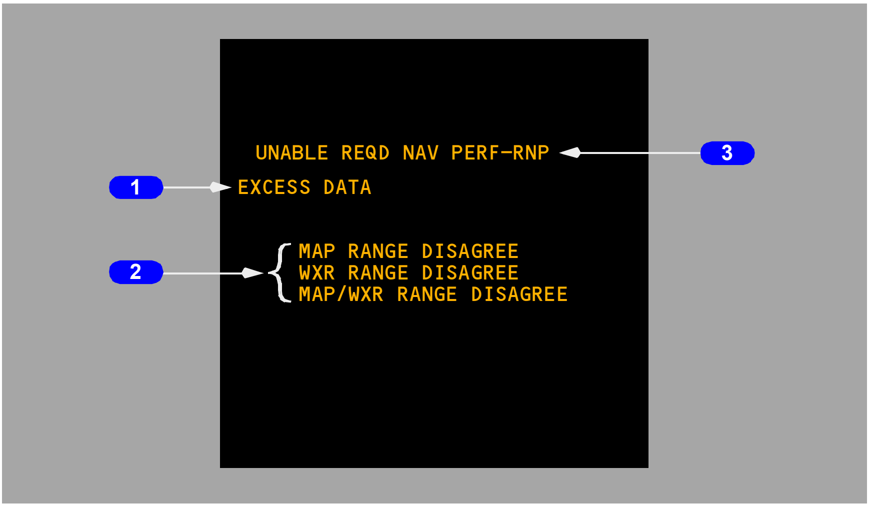


1 ON TAXIWAY (amber)

Appears each time the airplane:

- is on a surface other than a runway, and
- ground speed is greater than 40 knots

Navigation Displays – Advisory Messages
Navigation Advisory Messages



1 Excess Data Annunciation (amber)

The amount of map information sent to the primary display system is too great to display. When this occurs, the system removes some information from the display.

The message can be cleared by:

- decluttering - removing unnecessary navigation information.
- reducing the display range.
- deselecting one or more of the EFIS MAP switches (STA, WPT, ARPT, DATA, POS).

2 Range Disagreement Annunciations (amber)

MAP RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP display range.

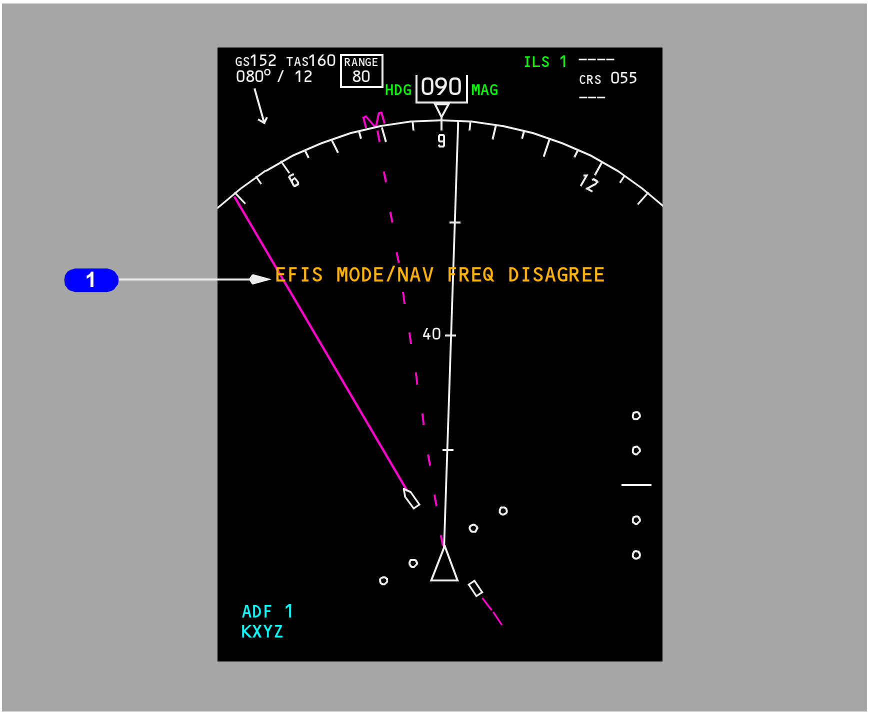
WXR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the WXR display range.

MAP/WXR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP and WXR display ranges.

3 Nav Advisory Message (amber)

UNABLE REQD NAV PERF– RNP – Displayed in MAP modes when FMC actual navigation performance is not sufficient for the displayed RNP. Refer to Chapter 11, Section 60, FMC Messages.

Mode/Frequency Disagree Annunciation



1 EFIS MODE/NAV FREQ DISAGREE (amber)

The ILS or VOR source annunciation corresponds to the position selected on the EFIS control panel and the tuned VOR/ILS frequency.

The annunciation is displayed:

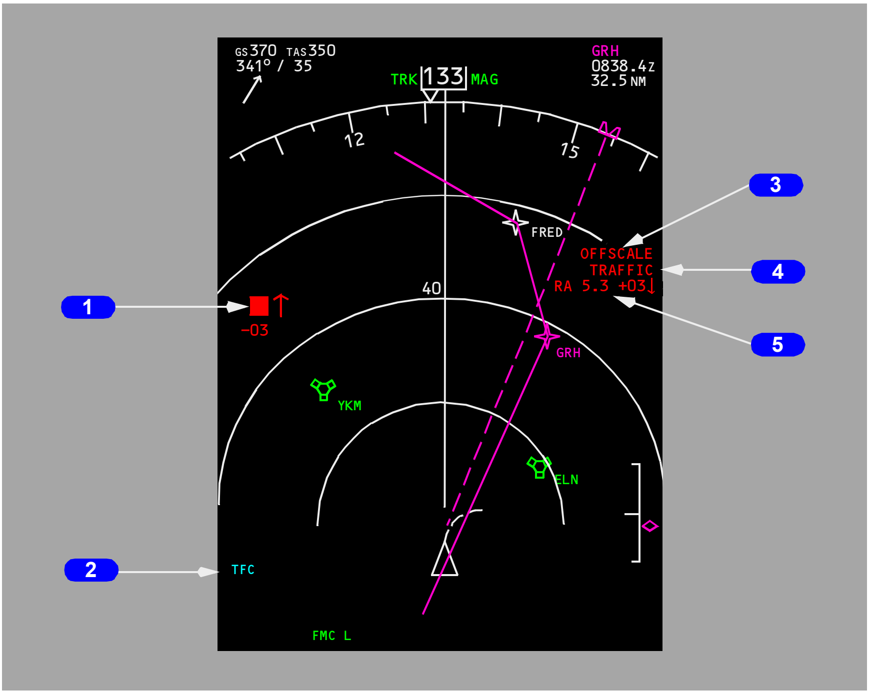
- if APP is selected with a VOR frequency tuned
- if VOR is selected with an ILS frequency tuned.

The DME display and ILS/VOR frequency at the upper right corner display dashes.

The localizer deviation bar, VOR course deviation bar and glideslope pointer are not displayed.

The annunciation is displayed in the expanded APP, center APP, expanded VOR and center VOR modes.

TCAS Messages



1 TCAS Traffic Symbols

Note: Refer to Section 40 of this chapter for a detailed explanation of the traffic symbology.

Indicates position of traffic targets.

Displayed in expanded MAP, center MAP, expanded APP and expanded VOR modes and TFC is selected on the EFIS control panel.

2 TCAS Annunciations

TFC (cyan) – Indicates TFC selected on EFIS control panel in expanded MAP, center MAP, expanded APP and expanded VOR.

TCAS TEST (cyan) – TCAS in test mode.

TA ONLY (cyan) – TCAS TA mode only.

TCAS OFF (amber) – TCAS off.

3 **Offscale (red or amber)**

TA (amber) or RA (red) is beyond the selected display range and TFC is selected on the EFIS control panel.

4 **Traffic (red or amber)**

Displayed during a TA (amber) or RA (red) condition whether or not TFC is selected on the EFIS control panel.

Shows in all navigation display modes.

5 **No–Bearing Messages (red or amber)**

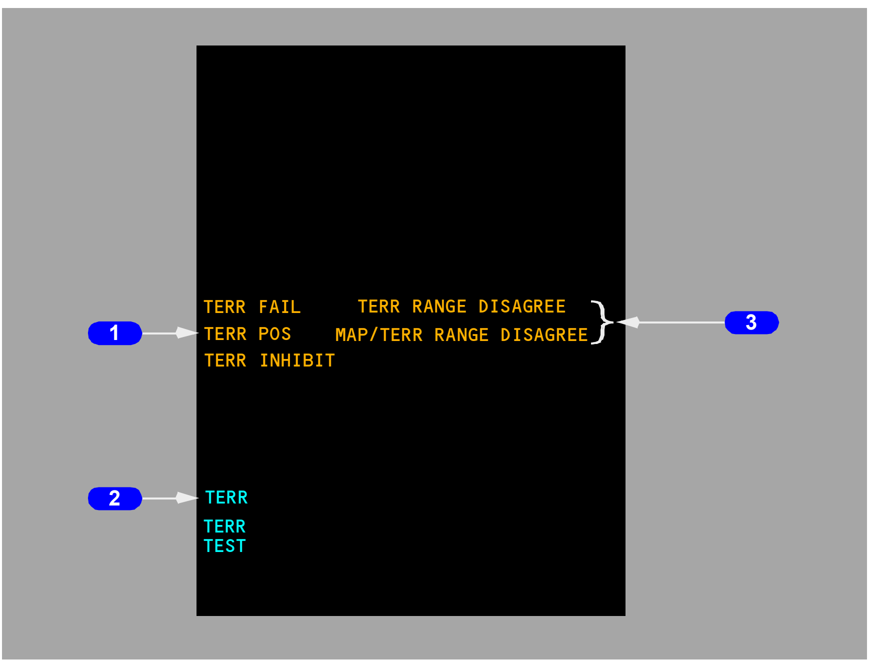
Textual description of TA (amber) or RA (red) traffic with no associated bearing.

Message provides traffic type, range in NM, altitude and a vertical motion arrow.

A maximum of two messages can be displayed simultaneously.

TFC selected on the EFIS control panel.

Look-Ahead Terrain Messages (GPWS)



1 **Terrain Status Annunciation (amber)**

TERR FAIL – Look-ahead terrain alerting and display have failed.

TERR POS – Look-ahead terrain alerting and display unavailable due to position uncertainty.

TERR INHIBIT – GPWS terrain inhibit switch in TERR INHIBIT position.

2 Terrain Mode Annunciation (cyan)

TERR – Terrain display enabled (manual or automatic display).

TERR TEST – GPWS is operating in self-test mode.

3 Terrain Range Status Annunciation (amber)

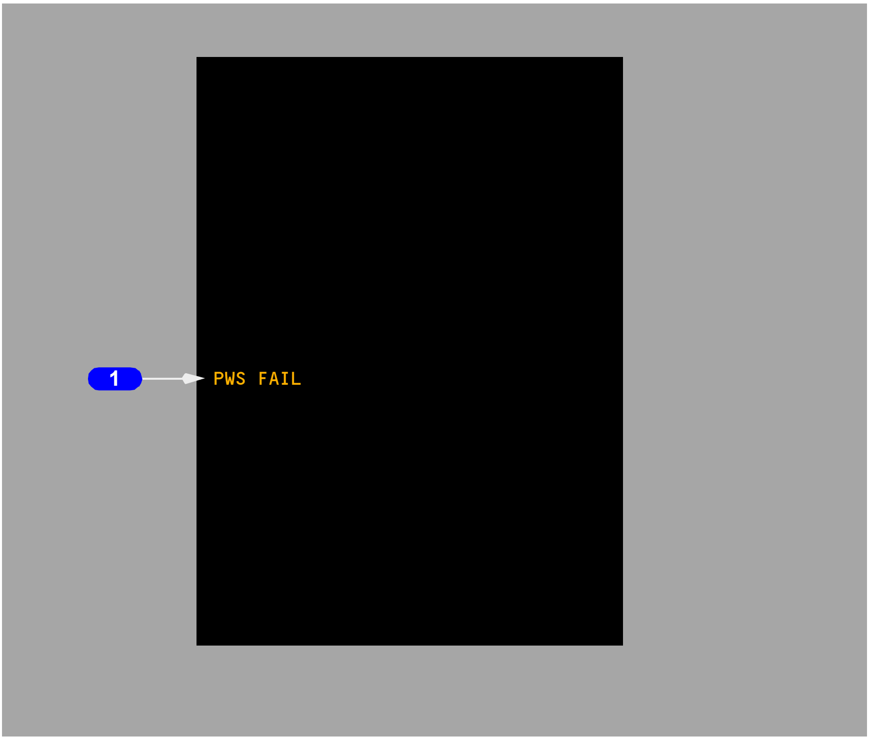
TERR RANGE DISAGREE –

- terrain display enabled, and
- terrain output range disagrees with selected EFIS control panel range.

MAP/TERR RANGE DISAGREE –

- terrain display enabled, and
- terrain output range disagrees with selected EFIS control panel range, and
- map display output range disagrees with selected EFIS control panel range.

Predictive Windshear System (PWS) Message



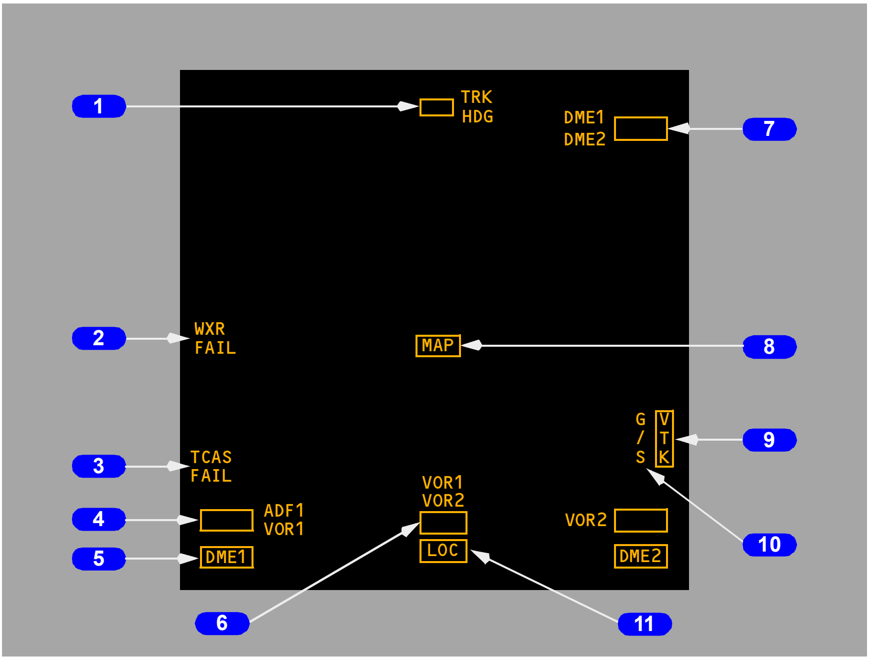
1 PWS FAIL Annunciation (amber)

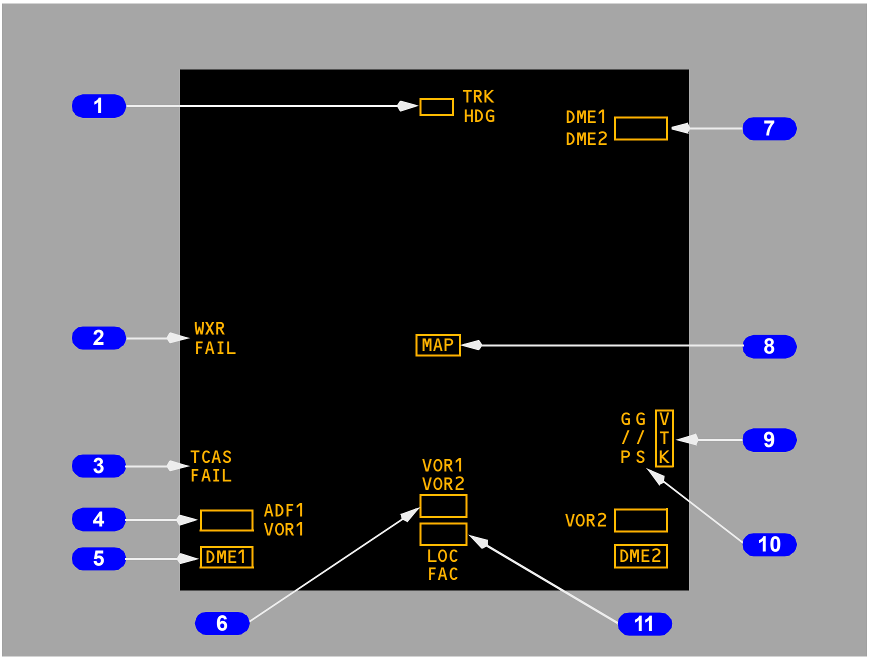
Predictive windshear alerting and display have failed.

Navigation Displays – Failure Indications and Flags

Dashes replace numbers if there is no computed information. Failure flags replace symbols or failure messages are displayed, as appropriate.

Center MAP, Expanded MAP, APP, & VOR Modes





1 Track Failure Flag (expanded and center MAP modes)

Track information failed. Track cannot be displayed.

2 Weather Radar Annunciations (expanded and center MAP, expanded APP, expanded VOR modes)

WXR FAIL – Weather radar has failed. No weather data are displayed.

WXR WEAK – Weather radar calibration fault.

WXR ATT – Attitude stabilization for antenna has been lost.

WXR STAB – Antenna stabilization is off.

WXR DSP – Range data input has failed. Only displayed in WXR TEST

AUTOTILT FAIL – Automatic radar mode has failed.

3 TCAS Failure Flag (expanded and center MAP, expanded VOR, expanded APP, PLAN modes)

TCAS has failed.

4 ADF 1 or VOR 1 and VOR 2 Failure Flag (expanded and center MAP, expanded APP, expanded VOR modes)

ADF or VOR has failed.

5 DME 1 and DME 2 Failure Flag (expanded and center MAP, expanded APP, expanded VOR modes)

Selected VOR DME has failed.

6 VOR 1, 2 Failure Flag (expanded VOR mode)

VOR has failed.

7 Reference VOR DME (expanded VOR mode) and Reference ILS DME (expanded APP mode)

Reference VOR or ILS DME has failed.

8 MAP Failure Flag (expanded and center MAP, PLAN modes)

The related FMC generated map display has failed.

9 Vertical Track Failure Flag (expanded and center MAP modes)

FMC vertical track data is invalid.

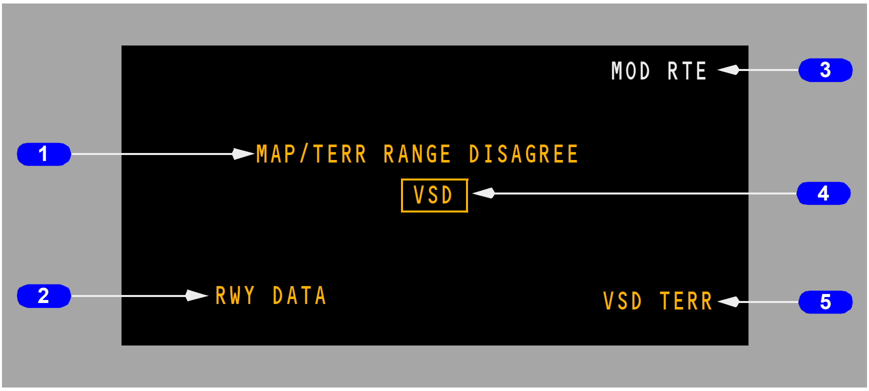
10 ILS Glideslope Failure Flag (expanded APP mode)

ILS glideslope has failed.

11 ILS Localizer Failure Flag (expanded APP mode)

ILS localizer course indication has failed.

Vertical Situation Display (VSD)



1 Range Disagreement Annunciations (amber)

MAP RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP display range.

TERR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the Terrain display range.

MAP/TERR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP and Terrain display ranges.

2 Runway Data Annunciation (amber)

FMC runway data is not available.

3 Route Waypoints Modification Annunciation (white)

FMC active route is being modified. Only active waypoint is displayed.

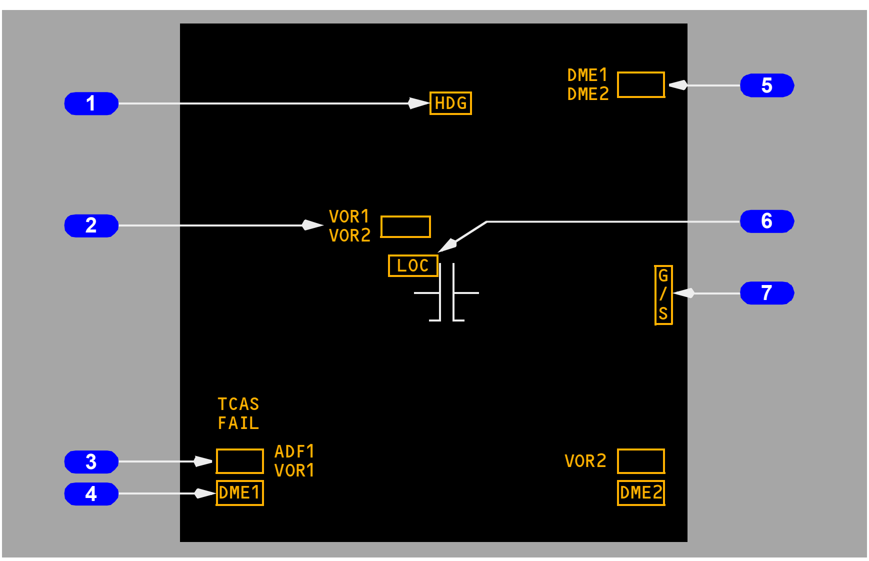
4 VSD Failure Flag (amber)

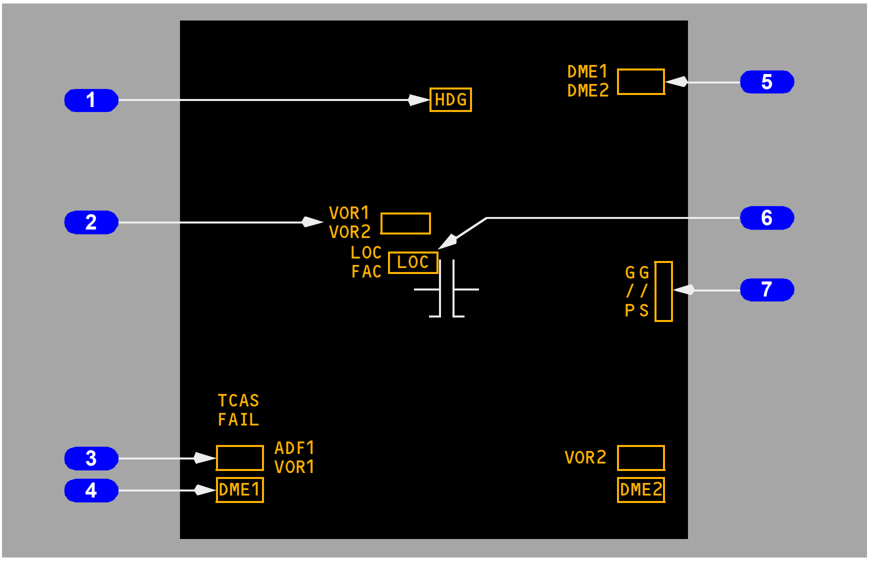
VSD cannot be displayed.

5 Terrain Data Failure Annunciation (amber)

EGPWS terrain data is not available. Annunciation is replaced with VSD TERR INHIBIT when GPWS control panel TERR INHIBIT switch is in the inhibit position.

Center APP and Center VOR Modes





1 Heading Failure Flag (center APP, center VOR modes)

Heading indication failed. Heading cannot be displayed.

2 VOR Failure Flag (center VOR mode)

VOR has failed.

3 ADF 1 or VOR 1 and VOR 2 Failure Flag (center APP, center VOR modes)

VOR or ADF has failed.

4 DME 1 and DME 2 Failure Flag (center APP, center VOR modes)

Selected VOR DME has failed.

5 Reference VOR DME (center VOR mode) and Reference ILS DME (center APP mode)

Reference VOR or ILS DME has failed.

6 ILS Localizer Failure Flag (center APP mode)

ILS localizer course indication has failed.

7 ILS Glideslope Failure Flag (center APP mode)

ILS glideslope has failed.

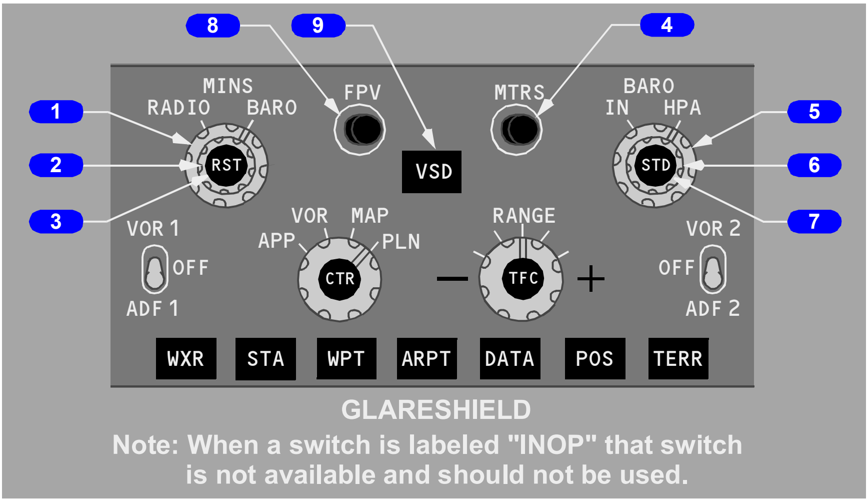
Intentionally
Blank

EFIS Control Panel

The left EFIS control panel controls the Captains outboard and inboard MFD units. The right EFIS control panel controls the First Officers outboard and inboard MFD units.

Pilots interact with the display suite using the EFIS Control Panel. The EFIS Control Panel allows the pilot to select information to be presented on the PFD and ND.

EFIS Control Panel Controls – Flight Instrument Displays



1 Minimums (MINS) Reference Selector (outer) (two position)

RADIO – selects radio altitude as the minimums reference.

BARO – selects barometric altitude as the minimums reference.

2 Minimums (MINS) Selector (middle) (slew)

ROTATE – adjusts the radio or baro minimums altitude.

3 Radio Minimums (MINS) Reset (RST) Switch (inner) (momentary action)

PUSH –

- resets the alert minimums annunciation
- blanks minimums display if alert is not active.

4 **Meters (MTRS) Switch (momentary action)**

PUSH – displays altitude indications in meters.

5 **Barometric (BARO) Reference Selector (outer) (two position)**

IN – selects inches of mercury as the barometric altitude reference.

HPA – selects hectopascals as the barometric altitude reference.

6 **Barometric (BARO) Selector (middle) (slew)**

ROTATE –

- adjusts the barometric altitude setting on the altitude tape
- if STD displayed, adjusts the preselected BARO reference.

7 **Barometric (BARO) Standard (STD) Switch (inner) (momentary action)**

PUSH –

- selects the standard barometric setting (29.92 inches Hg/1013 HPA) for barometric altitude reference
- if STD is displayed, selects the preselected barometric reference
- if no preselected barometric is displayed, displays the last value before STD was selected.

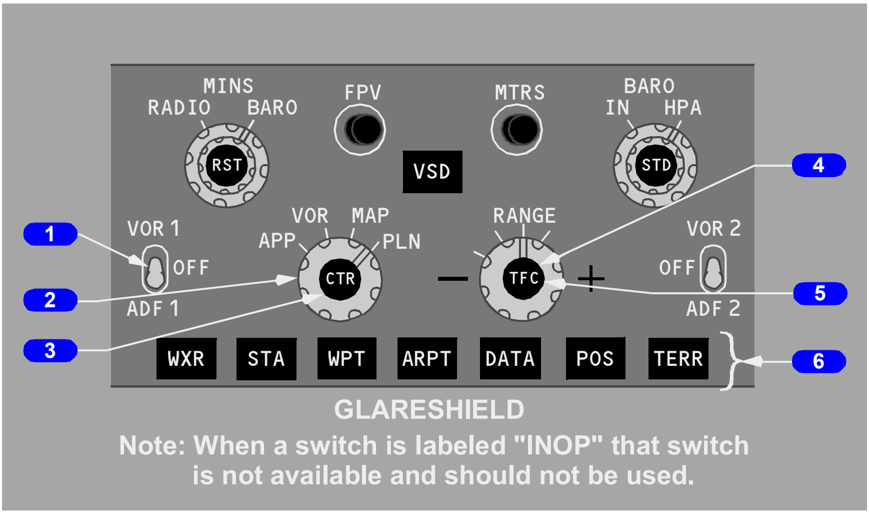
8 **Flight Path Vector (FPV) Switch (momentary action)**

PUSH – displays flight path vector on the attitude indicator.

9 **Vertical Situation Display (VSD) Switch (momentary action)**

PUSH – turns on the VSD inset on the Expanded MAP and Center Map modes on the ND. Pressing the VSD switch again will deselect the VSD. If the VSD switch is selected when the ND mode is not MAP, MDS will arm the VSD for display when the MAP mode is displayed.

EFIS Control Panel Controls – Navigation Displays



1 VOR/ADF Switch (three position)

Displays VOR or ADF information on all navigation modes except PLAN.

VOR – displays the selected VOR bearing pointer, frequency or identification and DME.

OFF – removes the VOR or ADF displays.

ADF – displays the selected ADF pointer and ADF frequency or identification.

2 Mode Selector (outer)

Selects the desired display.

APP –

- displays localizer and glideslope information in heading–up format.
- displays FAC and glide path information in heading–up format.
- displays reference IAN procedure, distance to missed approach point and source of IAN deviations
- displays reference ILS receiver, ILS frequency or identification, course and DME.
- displays reference GLS receiver, GLS channel/course and GLS distance
- weather radar, TCAS, and TERRAIN are not displayed in center APP mode.

VOR –

- displays VOR navigation information in heading–up format
- displays reference VOR receiver, VOR frequency or identification, course, DME and TO/FROM information
- weather radar, TCAS, and TERRAIN are not displayed in center VOR mode.

MAP –

- displays FMC generated route and MAP information, airplane position, heading and track, in a track–up format
- displays waypoints, including the active waypoint, within the selected range
- displays VNAV path deviation.

PLN –

- displays a non–moving, true north up, route depiction
- the airplane symbol represents actual airplane position and orientation
- allows route step–through using the CDU LEGS page
- weather radar, TCAS, and TERRAIN are not displayed.

3 Center (CTR) Switch (inner)

PUSH –

- displays the full compass rose (center) for APP, VOR and MAP modes

4 Range Selector (outer)

Selects desired display range in nautical miles for APP, VOR, MAP or PLN mode.

Range is shown on the ND.

5 Traffic (TFC) Switch (inner)

PUSH – displays TCAS information on the navigation display (refer to Chapter 10 sections 10.10 and 10.40).

6 MAP Switches (momentary action)

The MAP switches:

- add background data/symbols to MAP and center MAP modes
- displays can be selected simultaneously
- second push removes the information.

WXR (weather radar) – energizes weather radar transmitter and displays weather radar returns in MAP, center MAP, expanded VOR, and expanded APP modes. When the 640 nm range is selected, weather radar returns are limited to 320 nm (refer to Chapter 11, Flight Management, Navigation).

Note: WXR switch is automatically selected "OFF" in the event of an EFIS control panel failure in flight.

STA (station) –

- displays all FMC data base navigation aids if on map scales 5, 10, 20 or 40 nm
- displays FMC data base high altitude navigation aids on map scales 80, 160, 320 or 640 nm.

WPT (waypoint) – displays the waypoints in the FMC data base which are not in the flight plan route if the selected range is 40 nm or less.

ARPT (airport) – displays all airports which are stored in the FMC data base and which are within the viewable map area.

DATA – displays altitude constraint if applicable, estimated time of arrival and adds the RNP value for the subsequent leg on the navigation display when the route data is selected. An RNP value is only displayed when the subsequent leg defined in the NDB contains an RNP value and no manual RNP value has been entered. RNP values are also displayed on the Navigation Display when an RNAV (RNP) approach is selected and active and the "DATA" pushbutton is enabled.

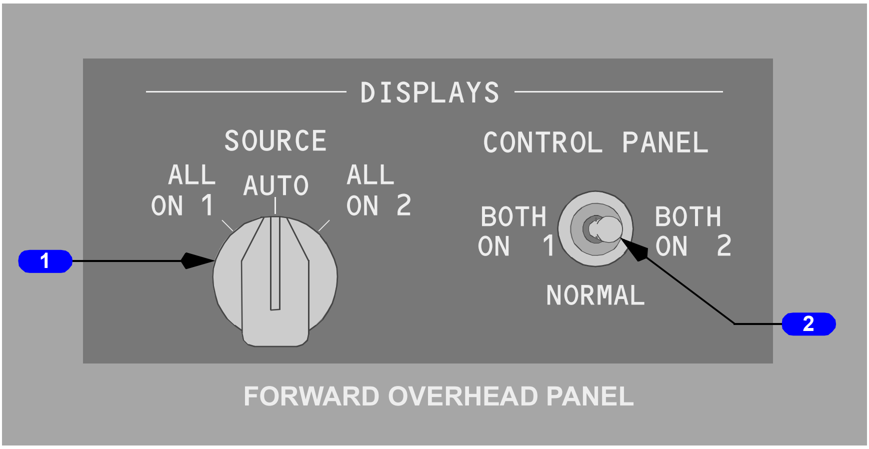
Route Data can be displayed on the lateral map area of the Vertical Situation Display (VSD) when in the VSD mode format. Displayed Route Data can be cycled on or off with the route “DATA” pushbutton.

POS (position) – displays IRS positions, GPS positions and VOR bearing vectors extended from the nose of the airplane symbol to the stations.

TERR (terrain) – displays GPWS generated terrain data in MAP, center MAP, VOR, and APP modes (refer to Chapter 15, Warning Systems).

Displays Source Control Panel

Both a display source Display Processing Computer (DPC) selector and an EFIS control switch are located above the Captain on the forward overhead (P5) panel.



1 Display Processing Computer– DPC

Both DPCs or only one DPC can drive all four Captain and First Officer displays. There is a SOURCE selector on the overhead panel. The selector is normally set to the AUTO mode:

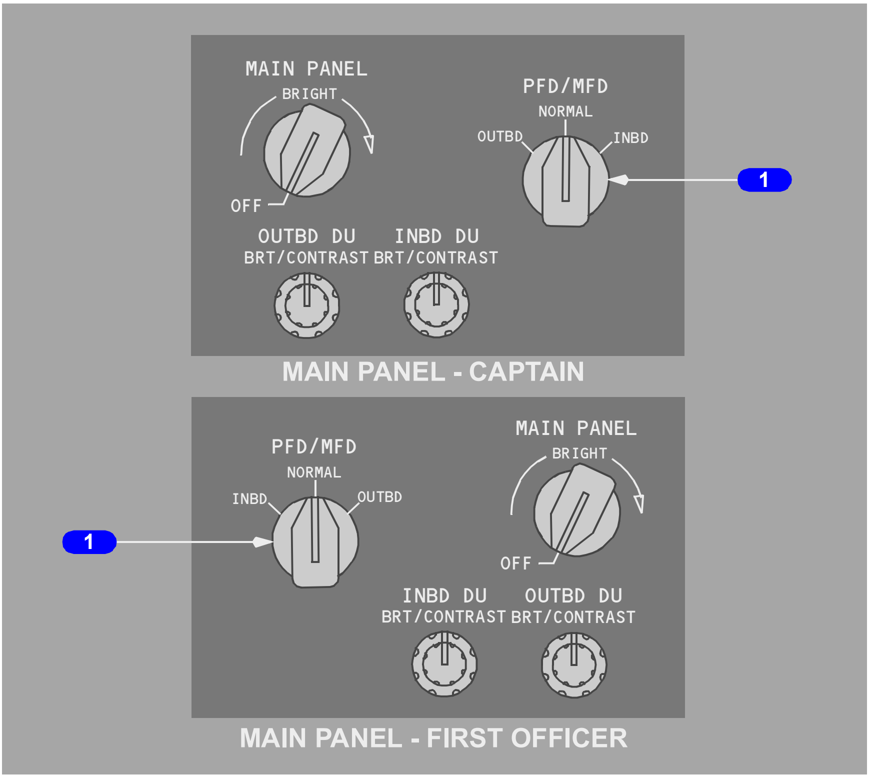
- ALL ON 1 – selects the Captain’s DPC to drive all four Captain and First Officer displays
- AUTO – allows DPC 1 to drive the Captains outboard and inboard, display units while DPC 2 drives the First Officer’s outboard and inboard display units. Provides automatic switching from both DPCs to one in case of a single DPC failure
- ALL ON 2 – selects the First Officer’s DPC to drive all four Captain and First Officer displays.

Note: These source selectors and switches are normally used while the aircraft is on the ground for maintenance purposes.

2 Displays Control Panel Switch – EFIS

- BOTH ON 1 – both pilots’ displays are set to the Captain’s EFIS control panel
- NORMAL – the left EFIS control panel controls the Captain’s displays and the right EFIS control panel controls the First Officer’s displays
- BOTH ON 2 – both pilots’ displays are set to the First Officer’s EFIS control panel.

Display Select Panels



1 Display Selector Switch

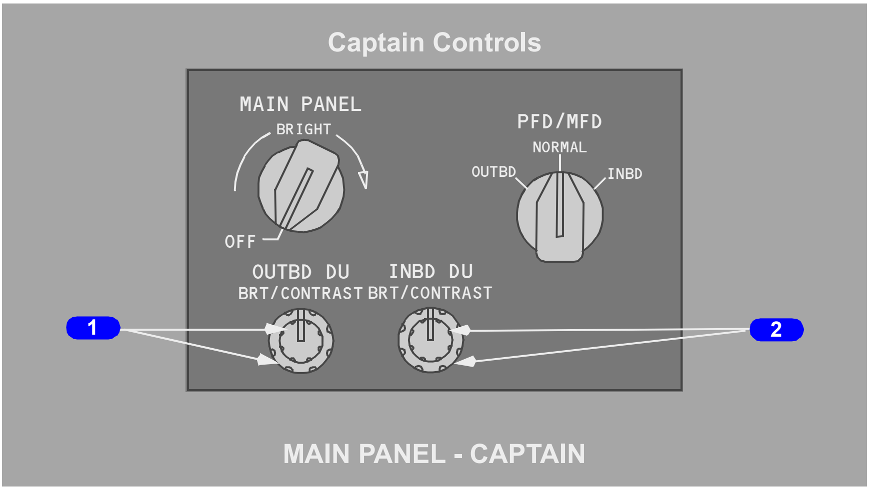
NORMAL – PFD/MFD configured in the normal display layout.

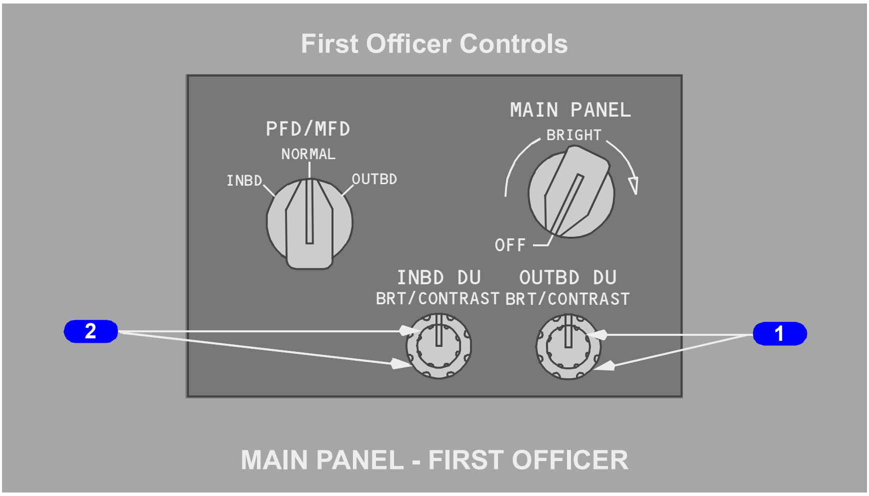
INBD – the outboard DU is blanked and the inboard DU displays the cropped PFD and the Engine display format if the Engine display format was previously displayed on this side. Otherwise, whichever display that was shown in place of the Engine display format before the failure will be shown.

OUTBD – the inboard DU is blanked. The outboard half of the outboard DU displays the cropped PFD. The inboard half displays the Engine display format if the engine display format was previously shown on that side of the flight deck. Otherwise, whichever display that was shown in place of the Engine display format before the failure will be shown.

Display Brightness Controls

The flight crew can individually adjust the brightness of each DU with manual rotary controls located below their respective outboard DU’s. The brightness controls for the Captain's Outboard and Inboard DU’s are located below the Captain's Outboard DU. The brightness controls for the First Officer's Inboard and Outboard DU’s are located below the First Officer's Outboard DU.





1 Outboard Display Brightness Control (OUTBD DU BRT/CONTRAST) (rotary)

ROTATE (inner) – adjusts weather radar/terrain brightness on respective outboard display.

ROTATE (outer) – adjusts respective outboard display brightness.

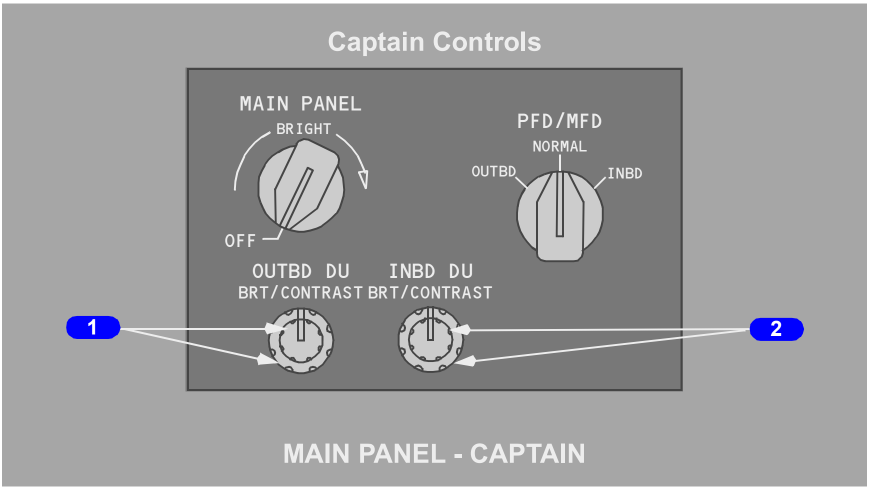
2 Inboard Display Brightness Control (INBD DU BRT/CONTRAST) (rotary)

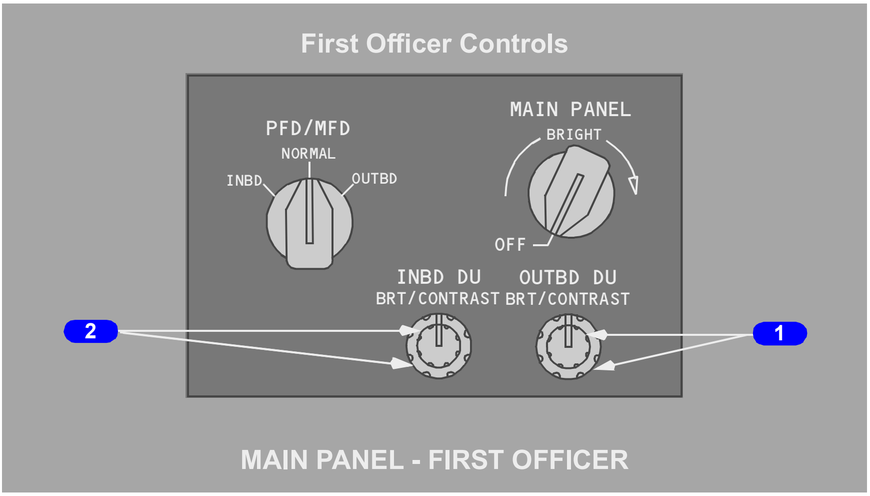
ROTATE (inner) – adjusts weather radar/terrain brightness on respective inboard display.

ROTATE (outer) – adjusts respective inboard display brightness.

Display Brightness Controls with Flight Deck Video

The flight crew can individually adjust the weather/terrain brightness and the contrast of the Flight Deck Entry Video on each DU with manual rotary controls located below their respective outboard DU's. The brightness and contrast controls for the Captain's Outboard and Inboard DU's are located below the Captain's Outboard DU. The brightness and contrast controls for the First Officer's Inboard and Outboard DU's are located below the First Officer's Outboard DU.





1 Outboard Display Brightness and Contrast Control (OUTBD DU BRT/CONTRAST) (rotary)

ROTATE (inner) – adjusts weather radar/terrain brightness and contrast of the Flight Deck Entry Video on respective outboard display.

ROTATE (outer) – adjusts respective outboard display brightness.

2 Inboard Display Brightness and Contrast Control (INBD DU BRT/CONTRAST) (rotary)

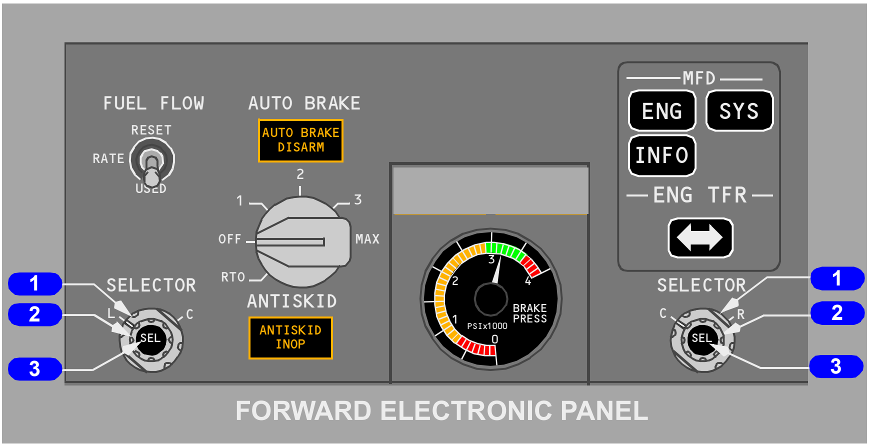
ROTATE (inner) – adjusts weather radar/terrain brightness and contrast of the Flight Deck Entry Video on respective inboard display.

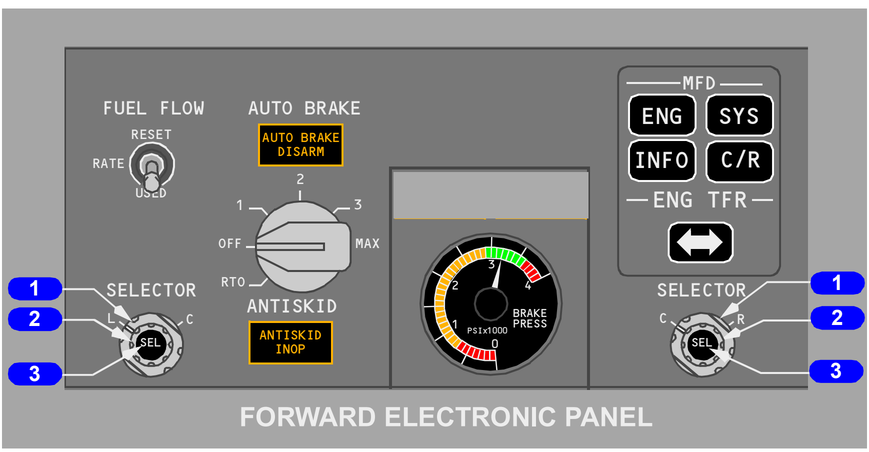
ROTATE (outer) – adjusts respective inboard display brightness.

Engine Display Control Panel

SELECTOR

Each pilot has an interactive display selector that allows the crew to interact with the MFD. Each selector consists of two stacked selectors with a push select switch on top.





1 Outer Selector

The two position outer selector commands the cursor and highlight to a display. The (L or R) selection places the cursor on the outboard half of the inboard display. The (C) selection places the cursor on the inboard half of the inboard display unit. The (L or R) selections are only used by maintenance when going through the maintenance formats on the main displays.

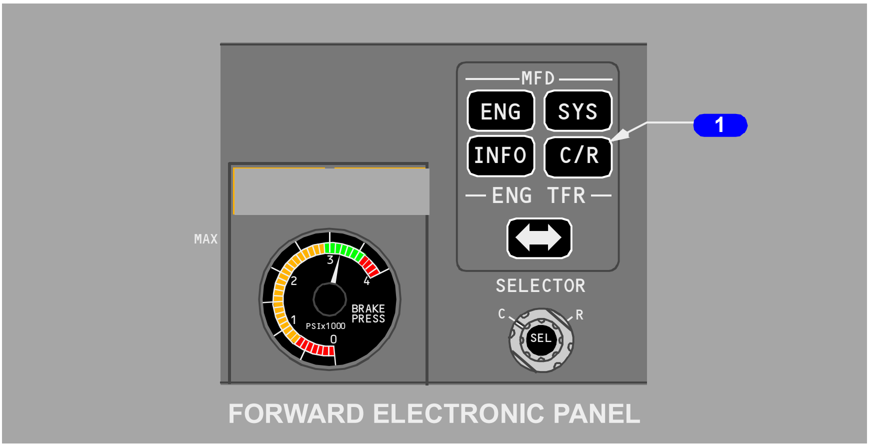
2 **Inner Selector**

The sixteen detent continuously rotating inner selector has two modes of operation. The default mode of the inner selector is to control the highlight position. Turning the inner selector in the default mode moves the cursor and highlight symbol from one radio button to another. The second mode of operation is data entry. When a data entry field is selected, the inner selector will stop controlling the highlight position and will begin controlling the value inside the data entry field. If the data entry field is a number, then turning the selector will increase or decrease the number.

3 **Select (SEL) Switch**

Interactive Radio buttons on the display are selected by moving the highlight to the desired Radio button and pressing the select (SEL) switch on the selector.

MFD Cancel/Recall (C/R) Switch

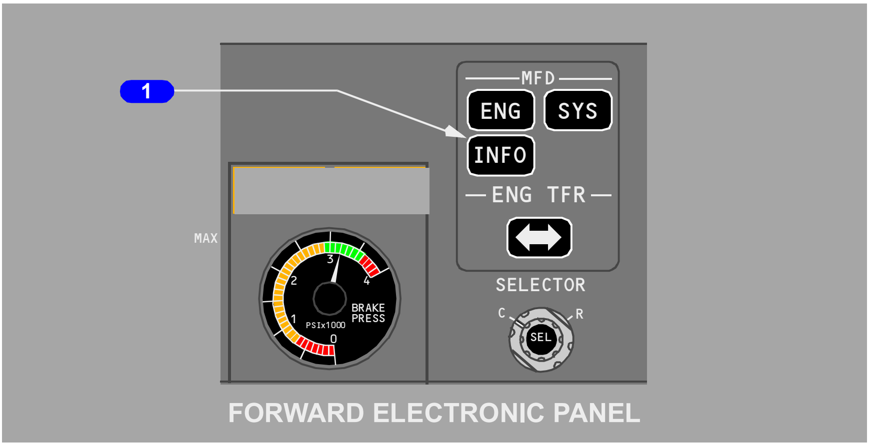


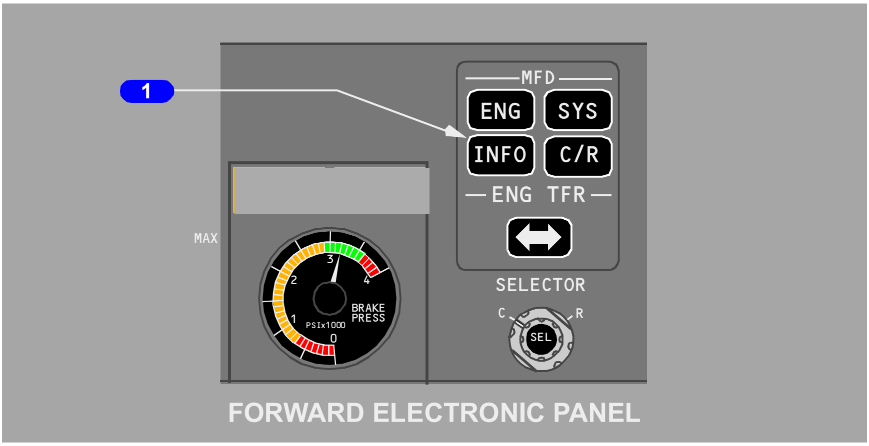
1 MFD Cancel/Recall (C/R) Switch

Push – cancels and recalls autoland advisory message.

- Refer to Chapter 15, Warning Systems.

INFO Display Format





1 MFD Information (INFO) Switch

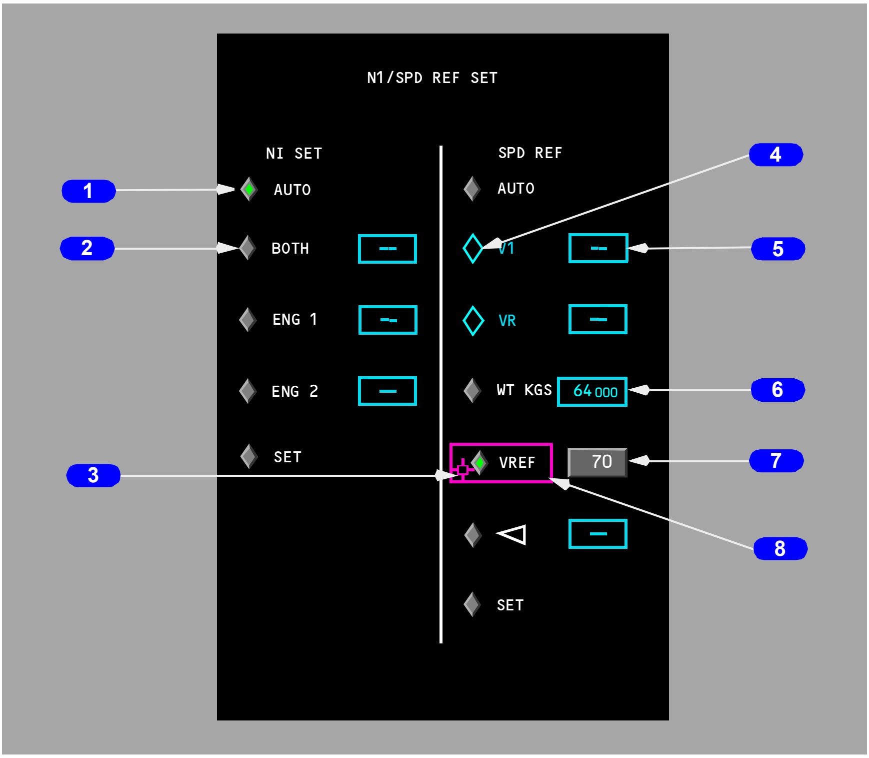
Push – shows the N1/SPD REF SET display where the crew can manually enter the N1 Targets and V speed bugs on the Airspeed indicator.

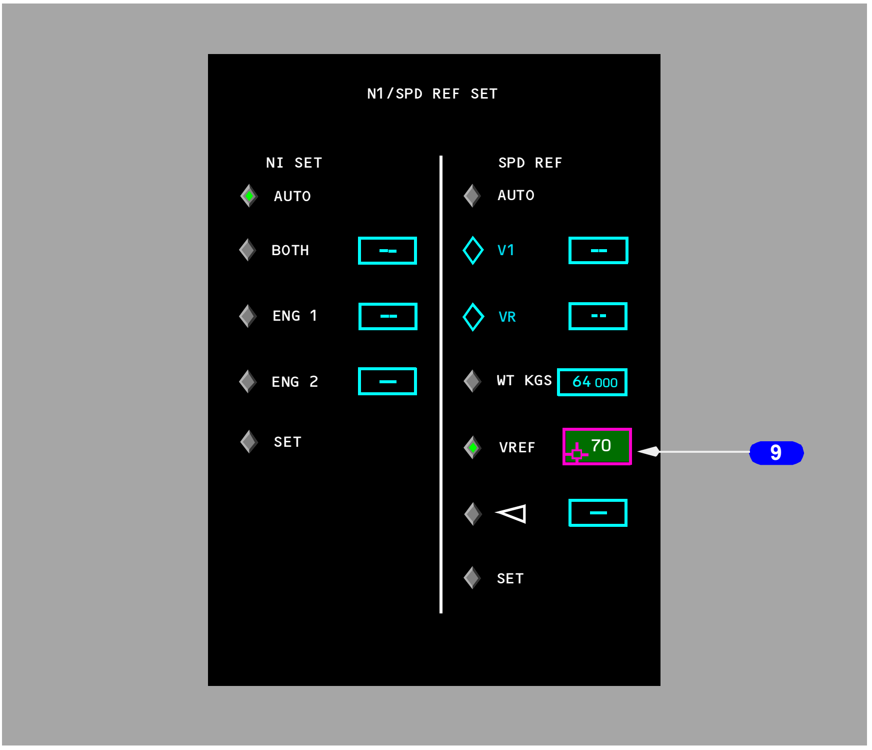
There are two sections to the INFO display function. The left side allows the manual setting of the N1 thrust target. The right side allows the manual setting of V speeds, gross weight and the white bug. The radio (diamond) buttons represent the various selections. When the radio button is gray, the button is enabled and can be highlighted and selected. When the radio button is cyan, the button is disabled and cannot be highlighted or selected.

The Captain and First Officer’s Selectors on the Engine Display Control Panel are used to interact with the INFO display format. When this format is selected for display, a highlight will appear on the AUTO radio button on the N1 SET side of the display. The inner selector is used to traverse down through the N1 SET radio buttons and then to the Speed Reference radio buttons.

Only one N1/SPD REF radio button can be active at a given time. The data entry field next to the radio button is disabled when the radio button is not selected or disabled (cyan). When a radio button is selected, the corresponding entry field will become enabled (gray). When an entry field is enabled, the field can be selected (green). When the entry field is selected, turning the inner selector knob increases and decreases the value.

The speeds will increment by 1 knot per click of the selector knob. Weights will adjust by 500 kgs per click of the selector. When the weight is in metric units, the inner knob is rate sensitive for the weight entry only. Turning the inner knob slowly will increment the value by 500 kgs per detent. Turning the inner knob quickly will increment the value by 1000 kgs per detent.





1 **Selected Enabled Radio Button**

2 **Un-Selected Enabled Radio Button**

3 **Cursor Shape Identifying Selector Controlling Highlight (Captain Shape shown)**

4 **Un-Selected Disabled Radio Button**

5 **Disabled Entry Field**

6 **Previously Entered/Completed Entry Field (Disabled)**

7 **Enabled Entry Field**

8 **Highlight (Controlled via Selector)**

9 **Selected Enabled Entry Field**

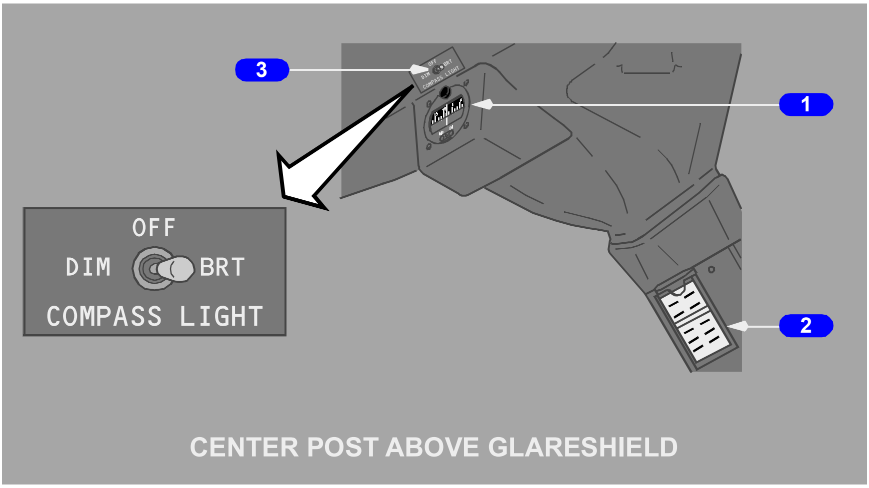
Changes Selectors to data entry mode.

Standby Flight Instruments

The standby flight instruments include the:

- standby magnetic compass
- integrated standby flight display

Standby Magnetic Compass



1 Standby Magnetic Compass

Displays magnetic heading.

2 Standby Magnetic Compass Correction Card

Provides appropriate heading corrections.

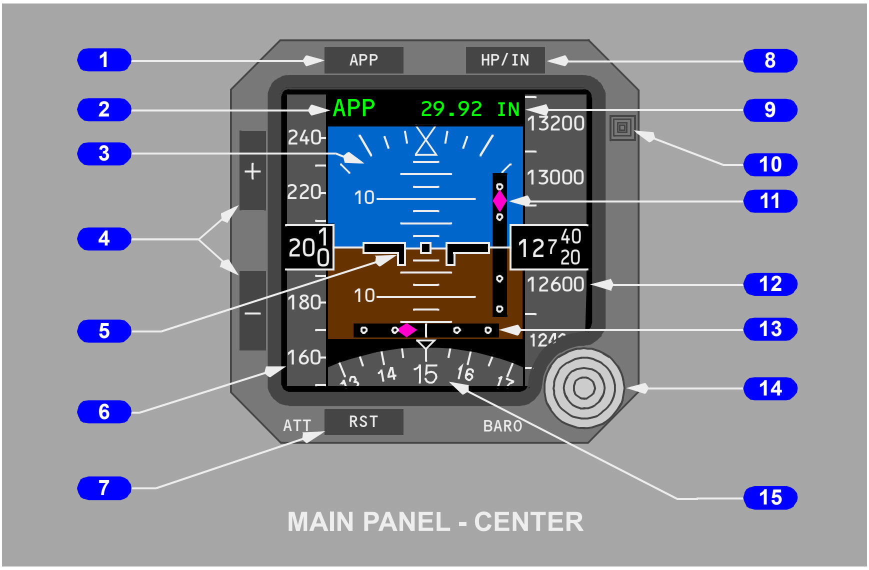
3 Compass Light Switch

OFF – compass light is extinguished.

BRT – sets compass light to full brightness.

DIM – sets compass light to low brightness.

Integrated Standby Flight Display



1 Approach (APP) Switch

Push –

- when blank, selects APP
- when APP displayed, selects BCRS
- when BCRS displayed, blanks.

2 Approach Mode Annunciation

Indicates approach mode selected.

- Blank – no approach deviation data displayed
- APP – ILS localizer and glideslope deviation data displayed
- BCRS (Back course) – reverses sensing for localizer pointer during back course approaches.

3 Attitude Display

Displays airplane attitude.

- Indicates bank in reference to the bank scale
- Indicates the horizon relative to the airplane symbol
- Beyond 30 degrees pitch, large red arrowheads (V-shaped) indicate the attitude has become excessive, and the direction to the horizon line.

4 **Display Brightness Switches**

Push –

- + increases display brightness
- – decreases display brightness.

5 **Airplane Symbol**

Indicates airplane attitude with reference to the horizon.

6 **Airspeed Indications**

Indicates current airspeed when above 30 knots.

7 **Attitude Reset (RST) Switch**

Push and hold at least two seconds

- aligns horizon with the airplane symbol
- reset takes approximately ten seconds
- starts new initialization sequence if previous attempt failed (ground only).

8 **Hectopascal/Inch (HP/IN) Switch**

Push – changes the units of the barometric reference.

9 **Barometric Setting**

Indicates the barometric setting selected with the barometric selector.

STD is displayed when selected with the barometric selector.

10 **Ambient Light Sensor**

Automatically adjusts display intensity for ambient lighting condition.

11 **Glideslope Pointer and Deviation Scale**

The glideslope pointer indicates glideslope position relative to the airplane.

- the pointer is in view when the glideslope signal is received
- the scale is in view when the APP mode is selected.
- the pointer and scale are removed when the BCRS mode is selected

12 **Current Altitude**

13 **Localizer Pointer and Deviation Scale**

The localizer pointer indicates localizer position relative to the airplane.

- the pointer is in view when the localizer signal is received
- the scale is in view when either the APP or BCRS mode is selected

14 Barometric (BARO) Selector

Rotate – changes barometric setting

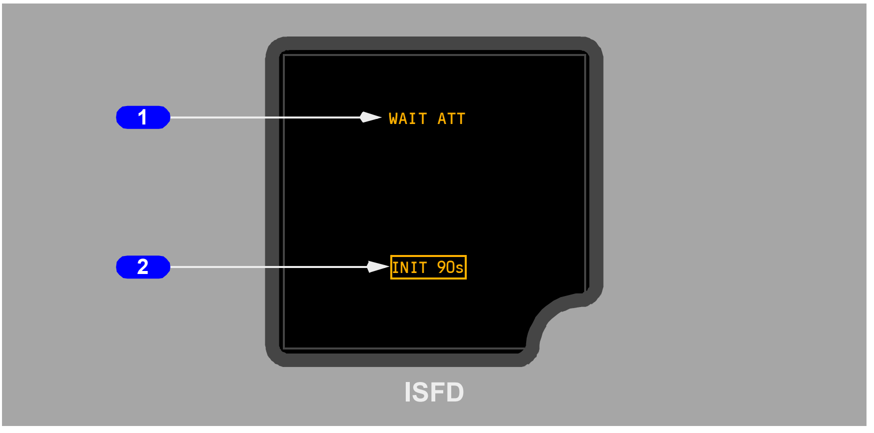
Push –

- selects standard barometric setting (29.92 inches Hg/1013 HPA)
- if STD is displayed, selects the preselected barometric setting.

15 Heading Indication

Displays airplane heading.

ISFD Messages



1 Attitude Messages

Indicates attitude display status.

- ATT:RST (amber) – attitude must be reset using the attitude reset switch
- ATT 10s (amber) – 10 second attitude realignment in progress
- WAIT ATT (amber) – indicates temporary self-correcting loss of attitude.

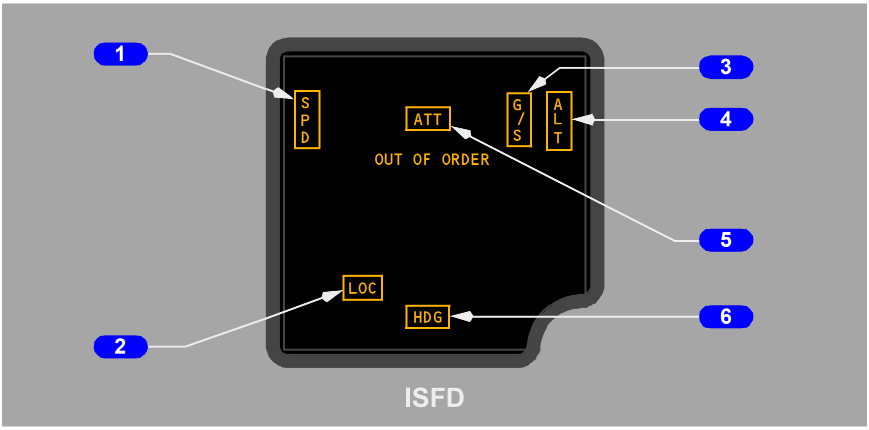
2 Initialization Message

INIT 90s (amber) – 90 second initialization countdown.

- countdown stops if excessive motion is detected
- countdown resumes when motion stops
- ATT:RST displays if initialization is not complete within six minutes.

ISFD Failure Flags

The OUT OF ORDER annunciation replaces the display when a total ISFD system failure occurs.



1 Airspeed flag

Airspeed information has failed.

2 ILS localizer failure flag

ILS localizer has failed.

3 ILS glideslope failure flag

ILS glideslope has failed.

4 Altitude flag

Altitude information has failed.

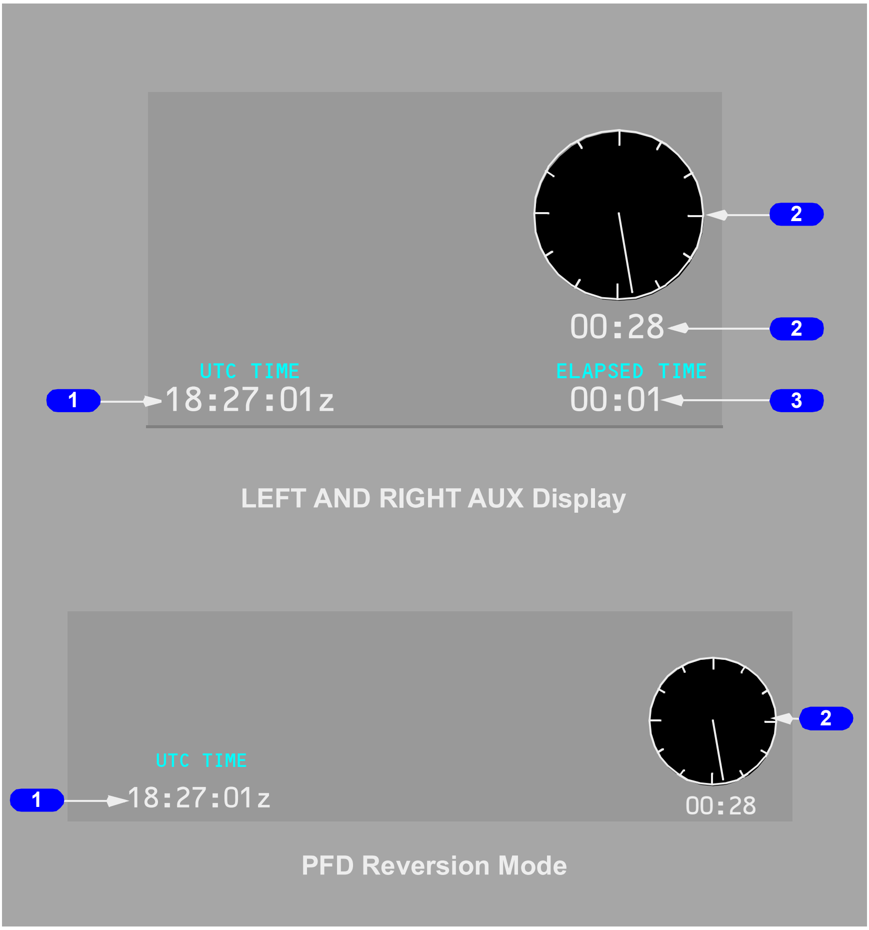
5 Attitude flag

Attitude information has failed.

6 Heading flag

Heading data has failed.

Clock



1 UTC Time

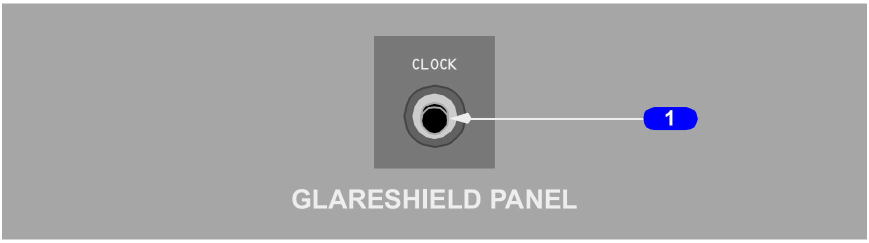
2 Chrono Dial and Readout

Major tick marks are placed at 0, 15, 30 and 45 seconds and minor tick marks are placed at 5, 10, 20, 25, 35, 40, 50 and 55 seconds.

3 Elapsed Time

Starts at weight off wheels, stops 30 seconds after weight on wheels and resets on power up or new origin airport RUNWAY is entered on the FMC route page.

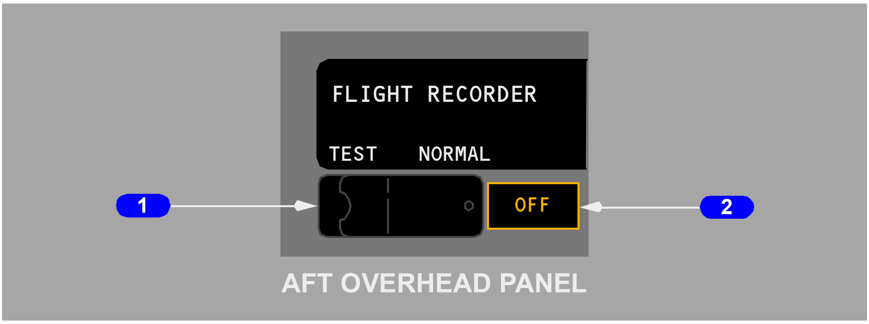
Clock Switch



1 Clock Switch

Push – first push displays and starts chrono function, second push stops chrono function, third push removes chrono.

Flight Recorder



1 Flight Recorder Test Switch

NORMAL (guarded position) –

- in flight – the recorder operates anytime electrical power is available
- on the ground – either engine must also be operating.

TEST – powers the flight recorder on the ground.

2 OFF Light (amber)

ILLUMINATED –

- indicates the recorder is not operating or the test is invalid
- may indicate power failure, loss of input data, or electronic malfunction.

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Introduction

The flight deck has four identical flat panel liquid crystal displays (LCD). The display unit positions are referred to as the Outboard DU's and Inboard DU's. An Outboard and Inboard DU is located on both the Captain's and First Officer's forward panel. The 28 VDC standby bus provides input power to the Left Captain's Outboard and Inboard DU's. The 28 VDC BUS 2 powers the Right First Officer's Inboard and Outboard DUs.

The DUs provide the flight crew with one Engine display, one Multi-function Display (MFD), and 2 Primary Flight Displays (PFDs), Navigation Displays (NDs), and Auxiliary Displays (AUX) formats.

Each DU is split into two regions to show two formats.

The Outboard DU's can show:

- PFD and AUX
- PFD and Engine Display
- PFD and MFD
- PFD and ND

The Inboard DU's can show:

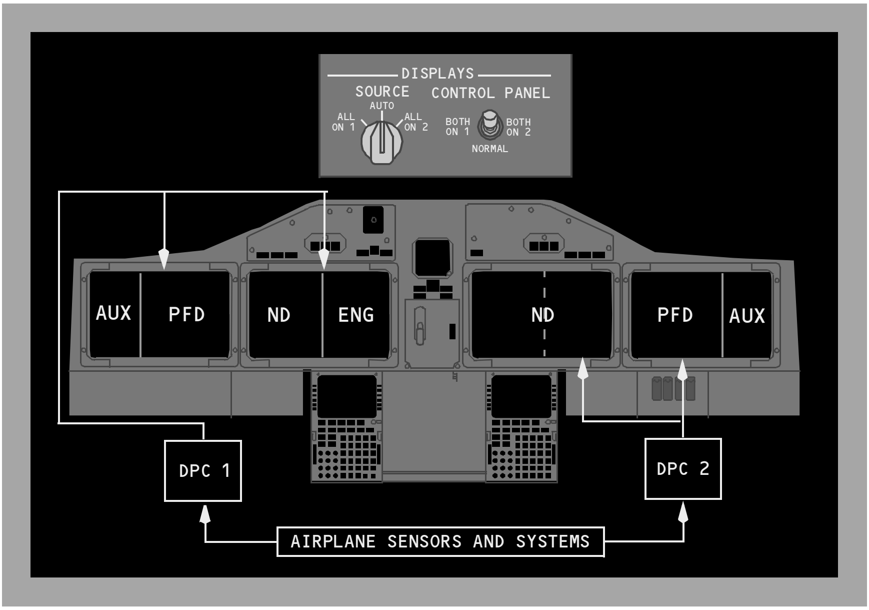
- PFD and Engine Display
- PFD and MFD
- PFD and ND
- Engine Display and ND
- ND and MFD

The Inboard DUs can also show a single format occupying the entire display for certain formats like the ND.

Display Brightness Control

Adjustment of the brightness of each DU is controlled by a combination of light sensors and brightness controls. Two remote light sensors, located left and right on the top of the glareshield, compensate for the amount of ambient light entering through the flight deck windows and adjust the brightness of the related DUs. Each DU also has an integral light sensor which provides automatic control of brightness as a function of ambient light striking the face of the DU. Brightness controls are used by the pilot to further adjust the intensity of each display unit.

DISPLAYS SOURCE Select Panel



The DISPLAYS source panel, located on the forward overhead panel, contains source controls for the Display Processing Computer (DPCs) and EFIS control panels.

The MAX Display System (MDS) utilizes two identical DPCs. Each DPC interfaces with airplane subsystems and sensors to collect data. The collected data is then processed and displayed on the flight deck DUs.

Each DPC is capable of providing completely independent sources of flight information presented on the Captain's and First Officer's displays. Normally DPC 1 supplies data to the Captain's displays, while DPC 2 supplies data to the First Officer's displays. Automatic switching is provided to select which DPC drives all four displays after a single DPC failure.

The DISPLAYS SOURCE select switch is located on the DISPLAYS Panel. The DISPLAYS SOURCE select switch allows the crew to manually select which DPC drives the DUs overriding the automation. The AUTO POSITION allows the automation to determine which DPC supplies data to each display and adjusts the source depending on various DU health and DPC failure conditions. If the displays are automatically or manually switched to a single DPC source, a DSPLY SOURCE 1 or 2 alert is shown on the primary flight displays.

The DISPLAYS CONTROL PANEL switch (labeled "CONTROL PANEL"), also located on the DISPLAYS panel, allows the crew to manually select which EFIS Control panel controls the captain and first officer displays. In the NORMAL position, the Captain's display instruments respond to the Captain's EFIS CP and the First Officer's display instruments respond to the First Officer's EFIS control panel. With the control switched to either BOTH ON 1 or BOTH ON 2, the selected EFIS control panel will provide inputs to MDS for the display of identical EFIS control functions on both sets of pilot displays. For example, with the Control Panel Select Switch in the BOTH ON 1 position, a baro setting entered on the Captain's EFIS control panel will be shown identically on both pilots' altimeter indications.

EFIS Control Panels

Two EFIS control panels, located on the glare shield of the center main panel, control display options, mode, and range for the related pilot's displays.

If one EFIS control panel fails, the displays can be controlled by the remaining control panel. Refer to the PFD and ND sections of this chapter for more information.

Display Select Switches

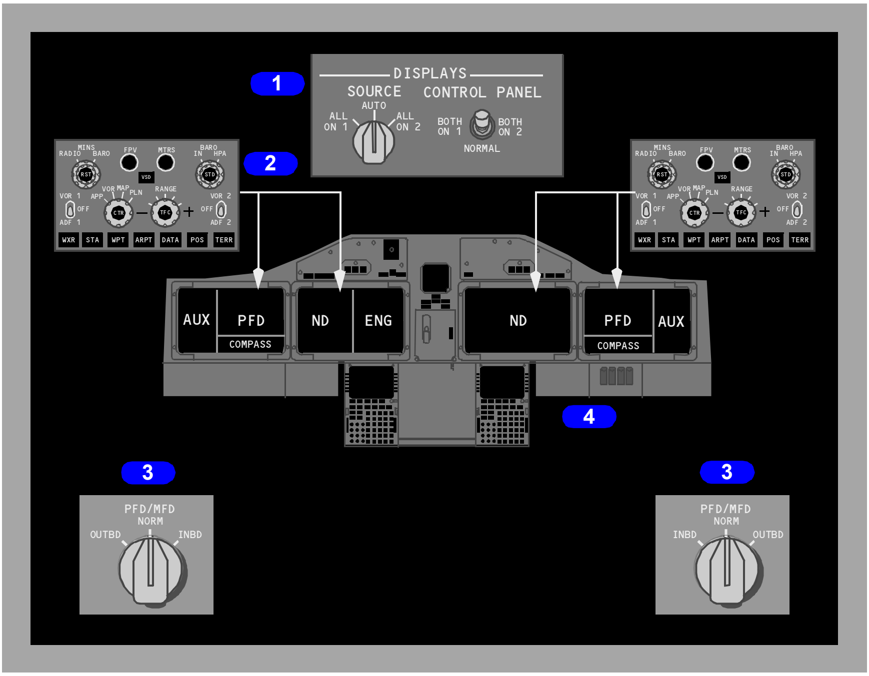
Display switching in the case of undetected DU failure is initiated using the Display Selector Switches located on each flight crew's Display Select Panels. When the switch is in the inboard (INBD) position, the outboard DU is blanked and the inboard DU displays the cropped PFD and the Engine display format if the Engine display format was previously displayed on this side. Otherwise, whichever display that was shown in place of the Engine display format before the failure will be shown. When the switch is in the outboard (OUTBD) position, the inboard DU is blanked. The outboard half of the outboard DU displays the cropped PFD. The inboard half displays the Engine display format if the engine display format was previously shown on that side of the flight deck. Otherwise, whichever display that was shown in place of the Engine display format before the failure will be shown.

When in the INBD or OUTBD position, a reduced size of the AUX display is also displayed above the reduced size PFD.

Display Selection and Control Examples

The following examples show display selections.

Normal Display Configuration



1 DISPLAYS SOURCE Panel

The DISPLAY SOURCE select switch is in AUTO and the CONTROL PANEL select switch is in NORMAL.

2 EFIS Control Panel

The left EFIS control panel controls the Captain outboard and inboard display units. The right EFIS control panel controls the First Officer outboard and inboard display units.

3 Display Select Panel

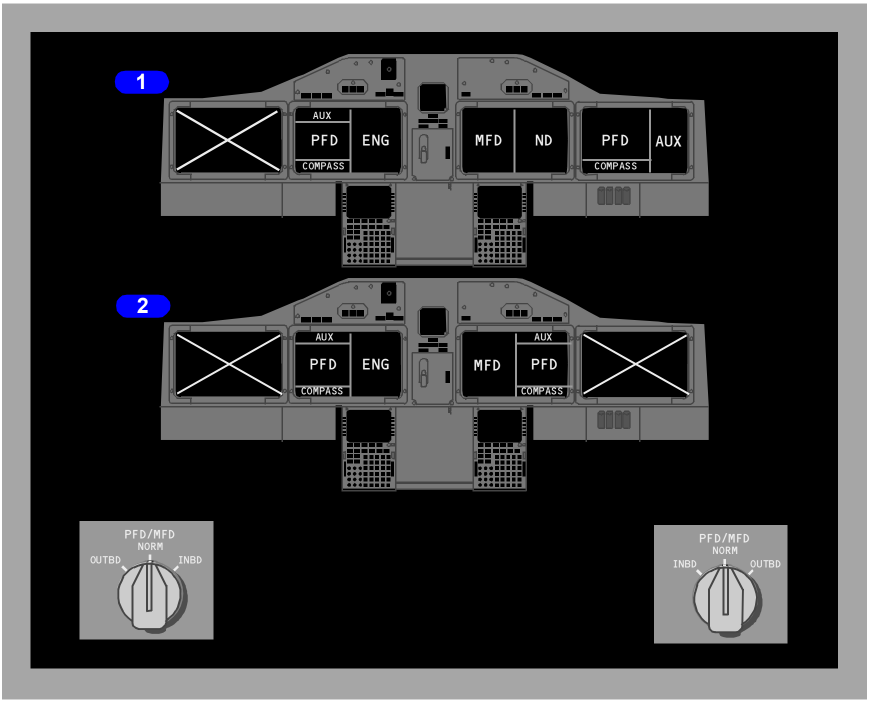
All selectors are in NORMAL.

4 Display Units

- The PFD and AUX displays will be shown on the Outboard DUs.
- The Captain's Inboard DU will show a half-sized ND and the Engine Display.
- The First Officer's Inboard DU will show a full-sized ND.

Display Unit Failure Automatic Switching

Outboard Display Unit Failure



1 Outboard Display Unit Fails

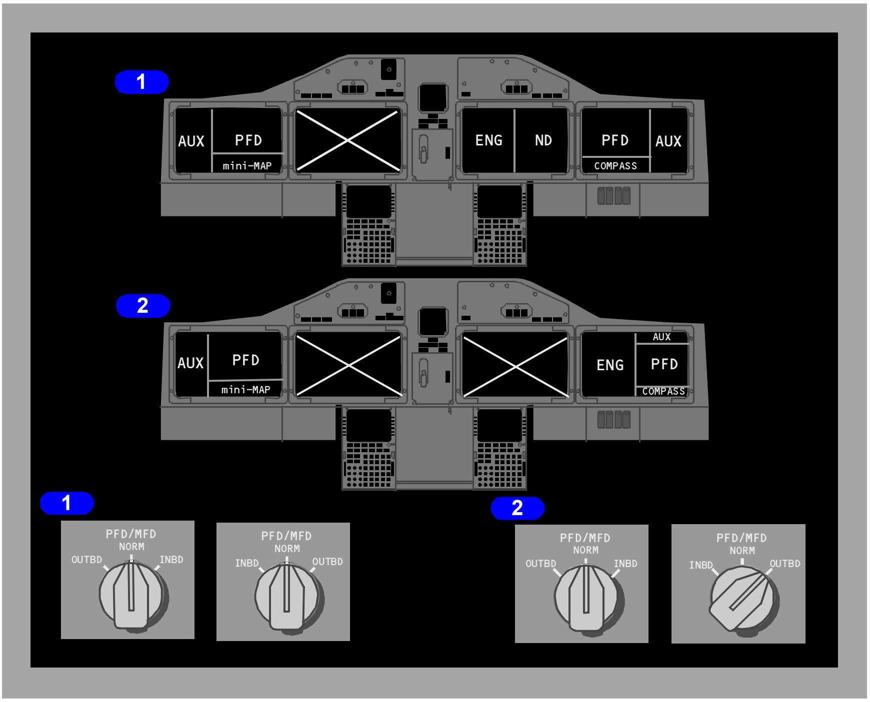
The window management function in MDS places the various display formats on the proper display units. It ensures that each pilot has a PFD, and that an Engine display is shown.

DU failures may be dealt with automatically or manually. When an outboard DU failure is sensed, the displays will automatically reconfigure. The MFD display adjacent to the failed DU is replaced by a reduced size PFD. The left and right edges of the PFD are cropped and the AUX display is removed from the side of the PFD. A condensed version of the AUX display is placed at the top of the PFD. This allows the half-sized PFD display to fit. No information on the PFD is lost with the half-sized display.

2 Both Outboard Display Units Fails

In the event that both outboard DUs fail, both inboard DUs will have the reduced size PFD as shown. If the failure is not detected, pilots can achieve the same reconfiguration pattern manually by switching the PFD/MFD selector to the INDB position.

Inboard Display Unit Failure



1 Inboard Display Unit Fails

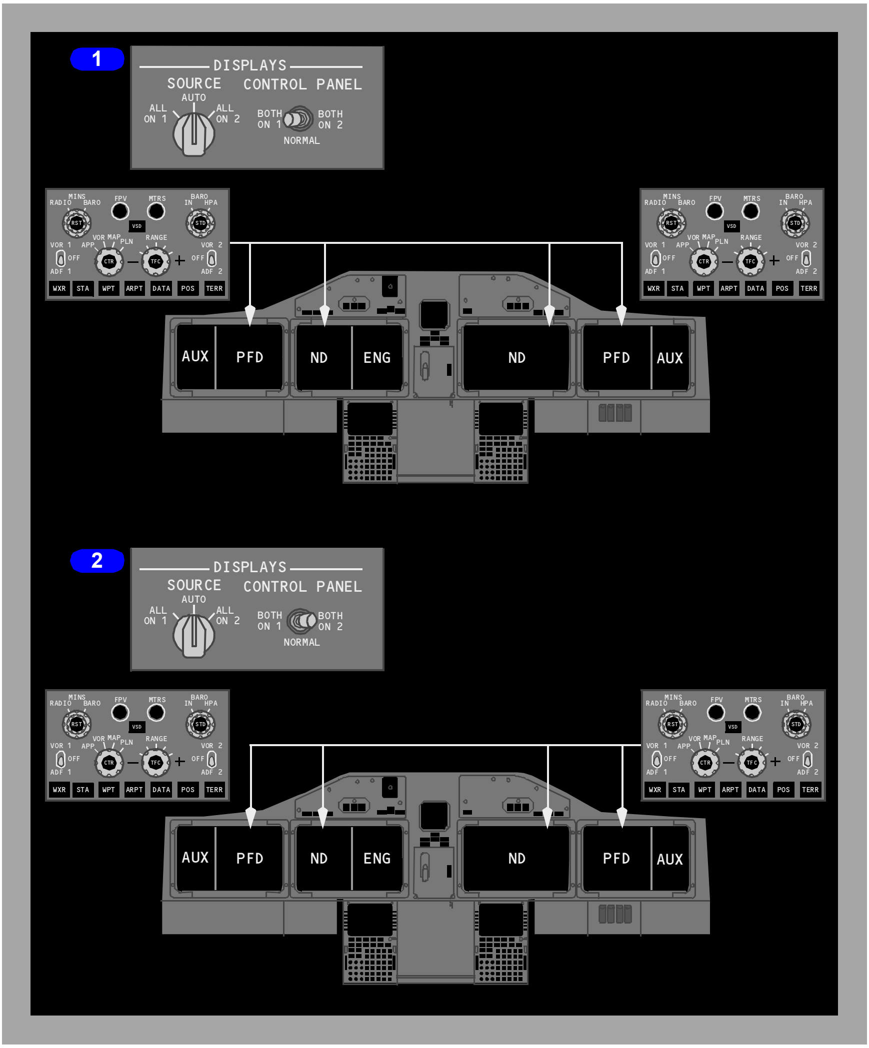
The window management function in MDS places the various display formats on the proper display units. It ensures that each pilot has a PFD, and that an Engine display is always shown.

When either inboard DU fails while displaying the Engine Display, the Engine Display will transfer to the remaining inboard DU. Unless the displays are manually reconfigured, the ENG TFR switch will not cause the Engine display to move to an inoperable DUs.

2 Both Inboard Display Units Fails

When both inboard DUs fail, the Engine Display will not be shown. The Display Select Switches can be used to show the Engine Display on the desired outboard DU.

EFIS Control Panel



1 CONTROL PANEL Select Switch BOTH ON 1

The left EFIS control panel controls both pilots' outboard and inboard display units.

2 CONTROL PANEL Select Switch BOTH ON 2

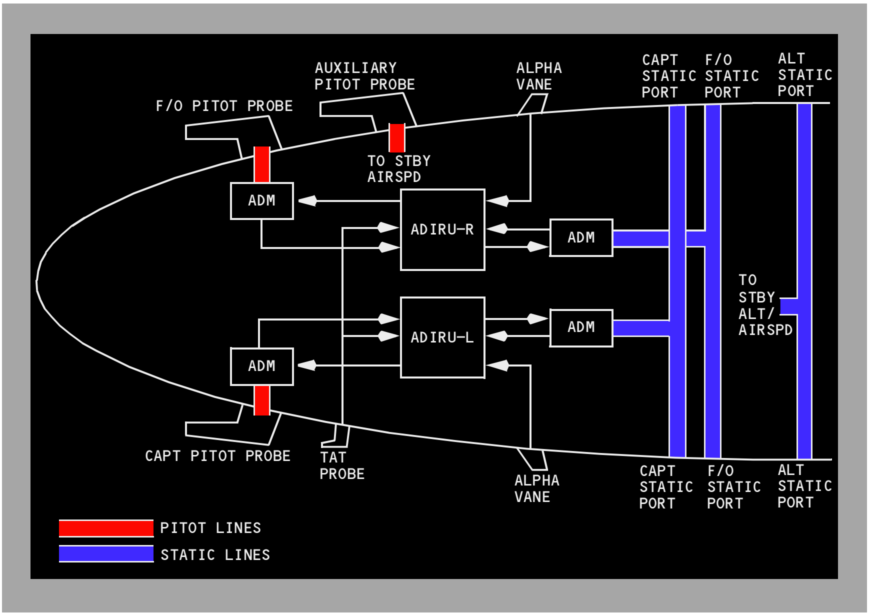
The right EFIS control panel controls both pilots' outboard and inboard display units.

Display System Information Sources
Air Data Inertial Reference System (ADIRS)

The ADIRS produces flight data such as position, speed, altitude and attitude for the flight displays, flight management computers, flight controls, engine controls and all other systems requiring inertial and air data.

The major components of the ADIRS are:

- two air data inertial reference units (ADIRUs)
- four air data modules (ADMs)
- one inertial system display unit (ISDU)
- one dual mode select unit (MSU)
- six static ports
- three pitot probes
- two alpha vanes
- one total air temperature probe



Air Data Inertial Reference Unit (ADIRU)

The ADIRUs provide inertial position and track data to the FMC as well as attitude, altitude and airspeed data to the displays. The ADIRUs process information measured by internal gyros and accelerometers, and from air data module inputs, the alpha vanes and other systems.

The ADIRU combines the Air Data System (ADR) and the Inertial Reference System (IRS) into a single Line Replicable Unit (LRU). For information about the IRS system, see Chapter 11.20, Flight Management and Navigation.

Air Data

The pitot static system is comprised of three separate pitot probes and six flush static ports. Two pitot probes and four static ports interface with the air data modules. The remaining auxiliary pitot probe and alternate static ports provide pitot and static pressure to the standby instruments. The auxiliary pitot probe is located on the first officer's side of the airplane.

The air data modules convert pneumatic pressure to electrical signals and send these data to the ADIRUs. Each pitot air data module is connected to its on–side pitot probe; there is no cross connection. The air data module connected to the Captain's pitot probe sends information to the left ADIRU, while the air data module connected to the First Officer's pitot probe sends information to the right ADIRU. The remaining air data modules are located at the balance centers of the Captain's and First Officer's static ports. The air data module connected to the Captain's static ports sends information to the left ADIRU, while the air data module connected to the First Officer's static ports sends information to the right ADIRU.

Angle–of–Attack

There are two alpha vanes, one located on each side of the forward fuselage. The vanes measure airplane angle–of–attack relative to the air mass.

The primary source of data for the AOA indicator on the PFD is supplied by the ADIRU, with the Stall Management Yaw Damper (SMYD) as the backup source. The source selection is automatic in the event of primary source failure. Slight differences between the Captain's and FO's indications may be noticed due to sideslip or vane installation errors. These differences could be as large as 2 degrees alpha.

Total Air Temperature (TAT)

A total air temperature probe is mounted outside the airplane to sense air mass temperature. The temperature sensed by the probe is used by the ADIRUs to compute total air temperature.

Note: For manual CDU input of OAT on the ground, TAT indication is approximate and should not be used in lieu of ambient OAT for takeoff performance.

Static Air Temperature (SAT)

Static air temperature, displayed on the CDU PROGRESS page, comes from the ADIRUs, using total air temperature probe information.

Standby Flight Instruments

The standby flight instruments include:

- standby magnetic compass
- integrated standby flight display

Standby Magnetic Compass

A standard liquid–damped magnetic standby compass is provided. A card located near the compass provides correction factors.

Integrated Standby Flight Display (ISFD)

The ISFD displays attitude, airspeed, altitude, localizer/glideslope deviation and magnetic heading information. Attitude information is computed from data provided by internal inertial sensors. Airspeed and altitude are computed from pneumatic pressure data provided by direct connections to the auxiliary pitot and alternate static sources. Localizer/Glideslope deviation is provided by the #1 MMR. Magnetic heading is provided by the ADIRU-L. Magnetic heading is not available in polar regions. The ISFD will automatically switch to True Heading when Magnetic Heading becomes unusable in polar regions.

Note: The standby magnetic compass must be used to validate information.

The battery bus powers the ISFD. Selecting the battery switch ON activates the ISFD. After 10 seconds, an initialization sequence begins that requires 90 seconds to complete. ATT and INIT 90s messages are displayed during initialization. Initialization will stop if airplane movement is excessive and will resume when airplane movement is acceptable for initialization. Upon completion of the initialization sequence, attitude information is displayed.

Detection of a momentary out-of-limit ISFD condition may cause the attitude display to blank and the WAIT ATT or ATT:RST message to display. Operation of the attitude reset switch is required in response to the ATT:RST message. This will reset the horizon line with the airplane symbol.

On the ground, operation of the attitude reset switch must be performed with the airplane stationary. In flight, operation of the attitude reset switch must be performed with the airplane in wings level, non-accelerated flight. During the process, the ATT 10s message displays. Failure to maintain straight and level flight for 10 seconds may result in an ATT:RST message. If the reset attempt is unsuccessful, the ATT:RST message remains displayed and the ISFD does not enter normal operation.

Radio Altimeter (RA)

The radio altimeter measures airplane altitude above terrain. Radio altitude is displayed on the PFD.

Auxiliary (AUX) Display

The AUX area outboard of each PFD consists of clock and flight information. The clock and flight information is located in the upper part of the AUX display and includes:

- flight number
- transponder code
- SELCAL
- airplane tail number
- UTC time
- date
- elapsed flight time
- chrono dial and readout

Clocks

A clock is located on each AUX display. Each clock displays UTC time and date automatically generated from GPS. In addition to time, the clocks also provide elapsed time and chronograph functions. On power up, timer is set to 00:00. Elapsed time starts automatically at weight off wheels and ends at weight on wheels plus 30 seconds. When on the ground and a new origin airport RUNWAY is entered on the FMC route page, the elapsed time will reset to 00:00 when the route is activated. All clock functions except the chrono function are identical for both clocks. The pilots have independent control of the chrono displays.

Clock Switch (Chronometer Switch)

A remote clock switch, on the outboard portion of the glareshield, operates the chronometer.

Flight Recorder (DFDR)

The Digital Flight Data Recorder (DFDR) provides a permanent record of operational and systems information including time, heading, altitude, airspeed, acceleration, attitude, engine thrust, and flight control surface position.

The recorder is a solid state device and complies with Federal Aviation Administration and European Aviation Safety Agency requirements for data sampling rates and number/type of parameters sampled.

Operational and systems information are automatically recorded whenever the flight recorder is powered.

The DFDR has the following features:

- Continuously records the most recent flight data, saving the most current data for the last 25 hours of operation
- The DFDR is housed in a sealed container located behind an access door in the far aft cabin ceiling

- Corrosion, fire and impact resistant, survives deep sea pressure to 20,000 feet (6,096 m)
- Locator beacon operable for 90 days
- Receptacle for downloading and copying data for analysis.

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Introduction

The Primary Flight Displays (PFDs) present a dynamic color display of all the parameters necessary for flight path control. The displays provide the following information:

- flight mode annunciation
- airspeed
- altitude
- vertical speed
- attitude
- steering information
- part time mini-map
- radio altitude
- instrument landing system display
- approach minimums
- heading/track indications
- TCAS indications
- GPWS annunciations

The PFD consists of two general areas, the sky/ground attitude indicator and the compass/backup mini-MAP. The AUX Display is located outboard of each PFD. When the Display Select Switches are in the OUTBD or INBD positions the PFD and AUX Display are shown in a half screen format. In this configuration, the compass remains as a compass and does not become a backup mini-map.

Failure flags are displayed for airplane system failures. Displayed information is blanked or replaced by dashes if no valid information is available to the display system (because of out–of–range or malfunctioning navigation aids). Failure flags are displayed when aircraft systems cannot generate a reliable display.

Flight mode annunciations are described in Chapter 4, Automatic Flight.

Airspeed

Airspeed is displayed on a tape and in a digital window on the left side of the PFD. The current Mach number is digitally displayed below the airspeed tape when the current Mach number is 0.40 Mach or above. A groundspeed readout is displayed in the upper left corner of the compass/backup mini-MAP. An airspeed trend vector indicates predicted airspeed in 10 seconds. Selected airspeed is displayed above the airspeed tape.

Takeoff and landing reference speeds and flap maneuvering speeds are shown along the right edge of the airspeed tape. Maximum and minimum airspeeds are also displayed along the right edge of the airspeed tape.

Attitude

The attitude indication displays the airplane pitch and roll attitude referenced to the horizon.

Pitch attitude is displayed by an airplane symbol against a pitch scale. The pitch scale is in 2.5 degree increments.

A pointer indicates bank angle in increments of 10, 20, and 30 degrees. Single marks indicate 45 and 60 degrees of bank. A small rectangle under the bank angle pointer indicates slip and skid conditions. Bank angle is also represented by the attitude of the airplane symbol against the horizon line and pitch scale.

A pitch limit indication is displayed at all times when the flaps are not up. In some airplanes, when flaps are up and airspeed approaches stick shaker activation for existing flight conditions.

Angle of Attack

(as installed)

The Angle of Attack (AOA) indicator displays aircraft body angle of attack, stick shaker angle of attack, and the appropriate range of approach angle of attack. The indicator is located in the upper-right corner of the PFD, above the ADI.

If the AOA signal is determined to have failed or is invalid when ground speed is greater than 80 knots, the AOA indicator will be blanked and replaced with a fail flag.

During normal operation, the approach reference band moves with flap handle position. When the flap handle is in a landing flap detent, the band will depict the appropriate range of AOA for a Vref(xx)+5 approach, where Vref(xx) is for the corresponding flap detent position. If the flaps are driven in alternate mode, the band moves depending on actual flap position. If flap position is determined to be invalid, the band is blanked.

If an approach is flown faster than Vref(xx)+5, AOA is lower than normal and could potentially be below the band. If a slower approach is flown, AOA is higher than normal and could be above the band.

Steering Indications

The flight director is displayed when the related flight director switch is on. Pitch and roll commands are displayed independently.

The Flight Path Vector (FPV) symbol represents airplane flight path angle vertically and drift angle laterally. The flight path vector is displayed on the PFD when the EFIS control panel FPV switch is selected on. The FPV shows the Flight Path Angle (FPA) above or below the horizon line and drift angle left or right of the pitch scale's center. The FPA uses inertial and barometric altitude inputs. The vertical FPA is unreliable with unreliable primary altitude displays.

The FPV symbol is displayed in two brightness levels. The FPV symbol is displayed dim when either the flight director or a TCAS resolution advisory is displayed. The FPV symbol is displayed bright when the flight director is off and there is no TCAS resolution advisory displayed.

Instrument Landing System Indications

ILS glideslope and localizer deviation, frequency/identification, DME, course, and marker beacon indications are provided.

The approach reference information appears above and to the left of the attitude display. The ILS station identification or frequency, course, and (if available) DME are displayed.

The marker beacon indication (OM – outer marker, IM – inner marker, or MM – middle marker) is displayed in the upper right corner of the attitude display area.

The glideslope pointer and scale appear on the right side of the attitude indication when a valid signal is received. At low radio altitudes with autopilot engaged the scale turns amber and the pointer flashes to indicate an excessive glideslope deviation. The pointer is not displayed when the glideslope signal is unusable or when the track and the front course on the mode control panel differ by more than 90 degrees (backcourse).

The localizer pointer and scale appear at the bottom of the attitude indication when a valid signal is received. When the course deviation is slightly more than ½ dot, the localizer mode is engaged and track is within 5 degrees of the MCP selected course, the scale automatically expands. At low radio altitudes with autopilot engaged the scale turns amber and the pointer flashes to indicate excessive deviation. Below 1,000 feet AGL with LNAV engaged and LOC armed, the localizer scale turns amber and the pointer flashes if the localizer is not captured.

Each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second LOC and G/S deviation alerting display on each attitude indicator.

Below 2500 feet radio altitude with the localizer pointer in view, a rising runway symbol comes into view. The symbol provides lateral guidance. At 200 feet radio altitude, the symbol rises toward the airplane symbol.

Approach Minimums

The selected radio altitude or barometric approach minimums are set on the EFIS control panel. They are displayed near the bottom left of the altitude display.

Radio Altitude

The current radio altitude is displayed in the bottom center of the attitude indication area when radio altitude is below 2,500 feet AGL. The display turns amber when the radio altitude is below the radio altitude minimums.

Altitude

Altitude is displayed on an altitude tape along the right side of the PFD. It is also shown digitally in a window in the middle of the tape. When meters is selected on the EFIS control panel:

- current altitude in meters is also shown above the altitude window
- selected altitude in meters is displayed above the altitude tape.

Selected altitude is displayed above the altitude tape and is boxed when approaching the selected altitude. Selected altitude is also depicted with a bug on the altitude tape.

The selected barometric approach minimum is indicated on the altitude tape with a triangular pointer and a line when BARO minimums are selected. When RADIO minimums are selected, the pointer is still set at BARO minimums but there is no line.

A landing altitude reference bar is displayed along the inner edge of the altitude indication. The reference bar indicates the height above touchdown. A white bar is displayed from 1000 to 500 feet above landing altitude. An amber bar is displayed from 500 feet to the landing altitude.

A landing altitude indication is displayed as a crosshatched area and indicates:

- the FMC landing altitude for destination runway or airport, or
- the landing altitude for departure runway or airport until 400 NM from departure or one–half the distance to destination, whichever occurs first.

The current barometric reference is displayed below the altitude tape in either inches of mercury or hectopascals as selected on the EFIS control panel. A preselected barometric reference can be displayed when STD is displayed.

Vertical Speed

Vertical speed is displayed to the right of the altitude tape with a tape and pointer. Vertical speed is digitally displayed above or below the vertical speed display when vertical speed is greater than 400 feet per minute. It is displayed above with positive vertical speed and below with negative vertical speed. The selected vertical speed bug shows the selected vertical speed when in the AFDS vertical speed (V/S) pitch mode.

Heading/Track and Part Time Mini-Map Indications

Beneath the PFD is the compass and part time mini-MAP where heading/track information is shown. The part time mini-MAP is only available when the normal PFD and AUX Display are shown and the respective ND is not shown due to an inboard display failure.

The part time mini-MAP, a condensed version of the ND MAP allows the pilots to see their relationship to the flight plan and potential threats ahead. TCAS targets, terrain and weather can also be displayed (and in some instances will pop up) on the mini-MAP. Terrain, TCAS and Predictive Windshear alerts are annunciated on the mini-MAP. True Airspeed (TAS), Ground Speed (GS), Wind Direction, and Wind Speeds are also shown. The mini map range is fixed at 20 NM.

The selected heading readout (SEL HDG followed by the heading value and MAG/TRU) is shown at the bottom of the compass area. A line drawn perpendicular to the edge of the compass rose from the invisible center depicts the current airplane track.

Traffic Alert and Collision Avoidance (TCAS) Indications

TCAS resolution advisories are displayed in the attitude indication and vertical speed indication areas.

Refer to Chapter 15, Warning Systems.

GPWS Warnings

GPWS warnings are displayed in large capital letters between the attitude display and the heading/track compass rose. Refer to Chapter 15, Warning Systems.

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Introduction

The NDs provide a mode–selectable color flight progress display. The modes are:

- MAP
- VOR
- APP (approach)
- PLN (plan)

The MAP, VOR, and APP modes can be switched between an expanded mode with a partial compass rose and a centered mode with a full compass rose.

Each ND mode can be presented in a full or half screen display.

Map Mode

The MAP mode is recommended for most phases of flight. This mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- current track
- selected and current heading
- position trend vector
- range to selected altitude
- map range scale
- ground speed
- true airspeed
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- selected navigation data points

Navigation Data Points

Additional navigation facility (STA), waypoint (WPT), airport (ARPT), route progress (DATA) and position (POS) data are available for display on the ND in both the expanded and center map modes.

VOR and Approach Modes

The VOR and APP modes are presented heading up. The VOR and APP modes display track, heading, and wind speed and direction with VOR navigation or approach information.

Plan Mode

The PLN mode is presented true north up. The active route may be viewed using the STEP prompt on the CDU LEGS pages.

ND Information

Heading

Heading is supplied by the FMC or air data inertial reference system (ADIRS). The ND compass rose can be referenced to magnetic north or true north.

Track

Track is supplied by the FMC during normal operation.

Traffic

Traffic information from the TCAS can be displayed on the ND. TCAS is described in Chapter 15, Warning Systems.

Weather Radar

Weather radar information can be displayed on the ND. The weather radar system is described in Chapter 11, Flight Management, Navigation.

Failure Flags and Messages

Failure flags are displayed for system failures or invalid information. Indications are blanked or replaced by dashes when source system information is not available.

The message EXCESS DATA is displayed if the amount of information sent to the ND exceeds the display capability. When this occurs, the system removes some information from the display. The message can be removed by:

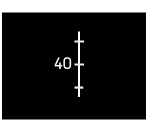
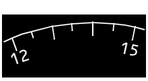
- reducing the amount of map information
- reducing range, or
- deselecting one or more of the EFIS control panel map switches (STA, WPT, ARPT, DATA, POS).

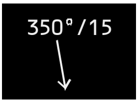
ND Symbology

The following symbols can be displayed on each ND, depending on EFIS control panel switch selections. Colors indicate the following:

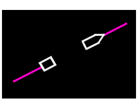
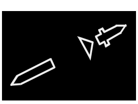
- W (white) – present status, range scales
- G (green) – dynamic conditions
- M (magenta) – command information, pointers, symbols, fly–to condition
- C (cyan) – nonactive or background information
- A (amber) – cautions, faults, flags
- R (red) – warnings
- B (black) – blank area, off condition.

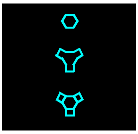
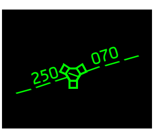
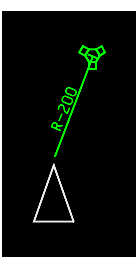
Heading, Track, and Speed

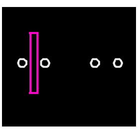
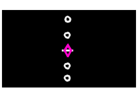
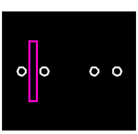
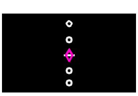
SYMBOL	NAME	MODE	REMARKS
	Selected heading bug (M)	All except PLN	Displays the MCP–selected heading. A dashed reference line (M) extends from the marker to the airplane symbol (VOR CTR and APP CTR do not display dashed line). In the MAP mode with LNAV or VORLOC engaged, the dashed line is removed 10 seconds after the selected heading bug is moved.
	Current heading pointer (W)	All except PLN	Points to current heading on the compass rose.
	Track line and range scale (W)	All except PLN	Indicates current track. Number indicates range (VOR CTR and APP CTR do not display range).
	Expanded compass (W)	MAP, VOR, APP	Displays 90 degrees of compass rose.
	Groundspeed (W)	All	Displays current groundspeed.

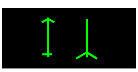
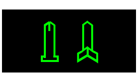
SYMBOL	NAME	MODE	REMARKS
	True airspeed (W)	All	Displays current true airspeed above 100 knots.
	Wind direction/ speed and wind arrow (W)	All	Indicates wind speed and direction, with respect to display orientation and heading/track reference. Displayed if wind magnitude is greater than 6 knots and blanked if wind magnitude becomes less than 4 knots. Blank until TAS is greater than 101 knots. PLN mode displays direction/speed without the arrow.
	Track orientation (G), current track (W), track reference (G)	MAP, MAP CTR	Displays TRK as the orientation, the current track, and MAG or TRU as the reference, and points to the heading on the compass rose.
	Heading orientation (G), current heading (W), heading reference (G), heading pointer (W)	VOR, VOR CTR, APP, APP CTR	Displays HDG as the display orientation, current heading, MAG or TRU as the heading reference, and points to the heading on the compass rose.

Radio Navigation

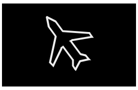
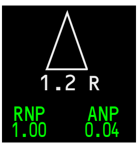
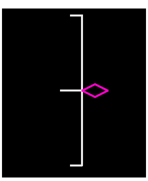
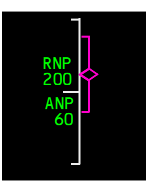
SYMBOL	NAME	MODE	REMARKS
116.80 OR SEA	ILS /VOR Reference receiver frequency or identifier display (W)	VOR, VOR CTR, APP, APP CTR	Located upper right corner. Frequency displayed before the identifier is decoded. The decoded identifier replaces the frequency. Medium size characters for VOR, small size characters for DME only.
CRS 135	Reference ILS or VOR course (W)	VOR, VOR CTR, APP, APP CTR	Located upper right corner. Indicates the VOR course or ILS localizer course.
DME 24.6	Reference VOR or ILS DME (W)	VOR, VOR CTR, APP, APP CTR	Located upper right corner. Indicates DME distance to the reference navaid.
DME 24.6	DME distance (G)	All except PLN	Located lower left or right corner. Indicates DME distance to navaid.
	Selected course pointer (W) and line (M)	VOR, APP	Displays selected course as set by the related MCP course selector.
	Selected course pointer (W) TO/FROM pointer (W)	APP CTR, VOR CTR	Displays selected course as set by the related MCP course selector. TO/FROM pointer is displayed when VOR navigation is being used.
TO FROM	To/from indication (W)	VOR, VOR CTR	Displays VOR to/from indication.

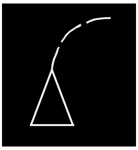
SYMBOL	NAME	MODE	REMARKS
	VOR (C, G), DME/TACAN (C, G), VORTAC (C, G)	MAP, MAP CTR, PLN	When the EFIS control panel STA map switch is selected on, appropriate navaids are displayed. All navaids contained in the FMC data base and within the MAP area are displayed when the selected range is 5, 10, 20 or 40 nm. Only high altitude navaids are displayed when the selected range is 80, 160, 320 or 640 nm. Nav aids not being used are displayed in cyan. Manually tuned VHF navaids are displayed in green, regardless of STA map switch selection.
	Manually tuned VOR radials (G)	MAP, MAP CTR, PLN	When a navaid is manually tuned, the selected course and reciprocal are displayed.
	VOR/DME raw data radial and distance (G)	MAP, MAP CTR	When the POS map switch is selected on, the station radial extends to the airplane.
	System source annunciation (G)	VOR, VOR CTR, APP, APP CTR	Indicates the selected receiver as the display reference.

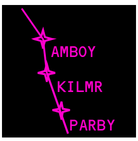
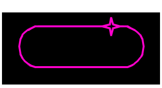
SYMBOL	NAME	MODE	REMARKS
VOR 1, 2 ILS 1, 2 GLS 1, 2	System source annunciation (G)	VOR, VOR CTR, APP, APP CTR	Indicates the selected receiver as the display reference.
ILS 1, 2 FMC L, R LOC1/G/P L LOC1/G/P R LOC2/G/P L LOC2/G/P R	IAN source annunciation (G)	APP, APP CTR	Indicates the selected source of the deviation displays.
	ILS localizer or VOR course deviation indication (M) and scale (W)	VOR, VOR CTR, APP, APP CTR	Displays LOC or VOR course deviation. Deviation indicator points in direction of VOR or ILS selected course. For ILS deviation, indicator fills (M) when less than 2 ½ dots from center.
	Glideslope pointer (M) and scale (W)	APP, APP CTR	Displays glideslope position and deviation.
	ILS localizer, FMC IAN or VOR course deviation indication (M) and scale (W)	VOR, VOR CTR, APP, APP CTR	Displays LOC, FMC IAN or VOR course deviation. Deviation indicator points in direction selected course. For ILS and FMC IAN deviation, indicator fills (M) when less than 2 ½ dots from center.
	ILS Glideslope or FMC IAN Glide path pointer (M) and scale (W)	APP, APP CTR	Displays glideslope or glide path position and deviation.

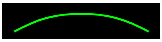
SYMBOL	NAME	MODE	REMARKS
	VOR frequency or identifier (G), ADF frequency or identifier (C)	All except PLN	Located lower left or right corner. Frequency is displayed before identifier is decoded. Decoded identifier replaces the frequency. For VORs, small size characters indicate only DME information is being received.
	VOR (G) or ADF (C) selection	All except PLN	Located lower left or right corner. Represents positions of the EFIS control panel VOR/ADF switches.
	VOR 1 (G) or ADF 1 (C) pointer head and tail	All except PLN	Indicates bearing to (head) or from (tail) the tuned station, if selected on the respective EFIS control panel.
	VOR 2 (G) pointer head and tail	All except PLN	Indicates bearing to (head) or from (tail) the tuned station, if selected on the respective EFIS control panel.

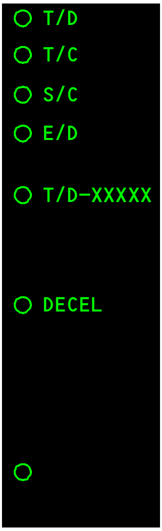
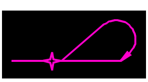
Map

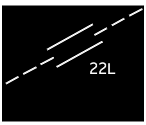
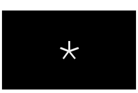
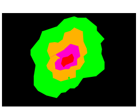
SYMBOL	NAME	MODE	REMARKS
	Airplane symbol (W)	VOR CTR, APP CTR	Current airplane position is at the center of the symbol.
	Airplane symbol (W)	PLN	Indicates actual position and track along the flight plan route. Inhibited north of 82N latitude and south of 82S latitude.
	Airplane symbol (W), Lateral ANP/RNP values (G)	MAP, MAP CTR, VOR, APP	Current airplane position is at the apex of the triangle. Displays lateral path deviation distance in MAP and MAP CTR mode only. Whenever ANP exceeds RNP, the ANP/RNP labels and values are displayed in amber.
	VNAV path pointer (M) and deviation scale (W)	MAP, MAP CTR	Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates ± 400 feet deviation. Digital display is provided when the pointer deviates more than ± 30 feet from center.
	Path deviation band (M), Vertical ANP/RNP values (G)	MAP, MAP CTR	Path deviation band is symmetric about the pointer and represents vertical RNP. Whenever ANP exceeds RNP, the ANP/RNP labels and values are displayed in amber.

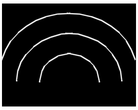
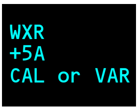
SYMBOL	NAME	MODE	REMARKS
	Position trend vector (W) (dashed line)	MAP, MAP CTR	Predicts position at the end of 30, 60, and 90 second intervals. Each segment represents 30 seconds. Based on bank angle and ground speed. Selected range determines the number of segments displayed. For range: • > 20 NM, 3 segments • = 20 NM, 2 segments • < = 10 NM, 1 segment.
	Active waypoint identifier (M)	MAP, MAP CTR, PLN	Indicates the active flight plan waypoint, the next waypoint on the route of flight.
	Active waypoint distance (W)	MAP, MAP CTR, PLN	Distance to the active waypoint.
	Active waypoint ETA (W)	MAP, MAP CTR, PLN	Indicates FMS–calculated ETA at the active waypoint.
	Waypoint: active (M), modified (W), inactive (C)	MAP, MAP CTR, PLN	Active– represents the waypoint the airplane is currently navigating to. Modified – represents the waypoints on the active route that are being modified. Inactive – represents the waypoints on the active route.

SYMBOL	NAME	MODE	REMARKS
	Off route waypoint (C)	MAP, MAP CTR, PLN	When the EFIS control panel WPT map switch is selected on, waypoints not on the selected route are displayed, for ranges of 5, 10, 20, or 40 NM.
	Flight plan route: active (M), modified (W), inactive (C), offset (M)	MAP, MAP CTR, PLN	The active route is displayed with a continuous line (M) between waypoints. Active route modifications are displayed with short dashes (W) between waypoints. Inactive routes are displayed with long dashes between waypoints. An offset route, selected through the FMC, is displayed with a dot–dash line (M) parallel to the active route.
	Route data: active (M), inactive (W)	MAP, MAP CTR, PLN	When the EFIS control panel DATA switch is selected on, entered or procedural altitude and ETAs for route waypoints are displayed.
	Holding pattern: active (M), modified (W), inactive (C)	MAP, MAP CTR, PLN	A holding pattern appears when in the flight plan. The holding pattern appears as a fixed size if the selected range is greater than 80 NM. A scaled representation of the holding pattern is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the holding fix.

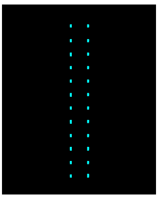
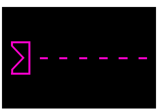
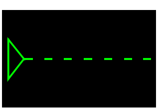
SYMBOL	NAME	MODE	REMARKS
 T/D-XXXXX	Altitude range arc (G)	MAP, MAP CTR	Based on vertical speed and groundspeed, indicates the approximate map position where the MCP altitude will be reached.
	Conditional waypoint: active (M), inactive (W)	MAP, MAP CTR, PLN	Active - represents the conditional waypoint event the airplane is currently navigating to. Inactive - represents the conditional waypoints on the route. Data within parentheses for conditional waypoints indicates type of conditional waypoint (ALTITUDE, COURSE INTERCEPT, etc.).

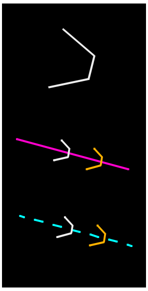
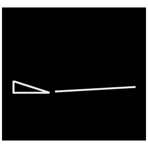
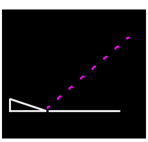
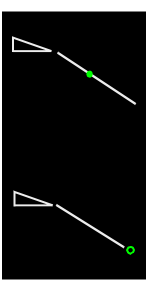
SYMBOL	NAME	MODE	REMARKS
	Altitude profile point and identifier (G)	MAP, MAP CTR, PLN	Indicates the approximate map position of the FMC–calculated T/C (top–of–climb), T/D (top–of–descent), S/C (step climb), and E/D (end of descent) points. Indicates intermediate T/D points for level flight path segments during descent. Level flight path segment altitude is displayed. Indicates the beginning of a deceleration segment resulting from deceleration to a holding pattern, a waypoint speed restriction or flaps up maneuvering speed. Indicates airport speed restriction deceleration point (no identifier).
	Procedure turn: active (M), modified (W), inactive (C)	MAP, MAP CTR, PLN	A procedure turn appears when in the flight plan. The procedure turn appears as a fixed size if the selected range is greater than 80 NM. A scaled representation of the procedure turn is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the procedure turn.
	Airport and runway (W)	MAP, MAP CTR, PLN	Displayed when selected as the origin or destination and selected range is 80, 160, 320, or 640 NM.

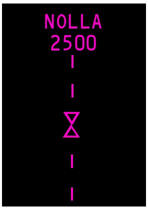
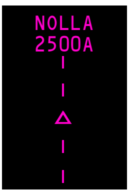
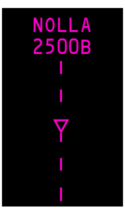
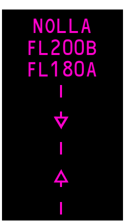
SYMBOL	NAME	MODE	REMARKS
	Airport (C)	MAP, MAP CTR, PLN	Displayed if the EFIS control panel ARPT map switch is selected on. Origin and destination airports are always displayed, regardless of map switch selection.
	Airport and runway (W)	MAP, MAP CTR, PLN	Displayed when selected as the origin or destination and selected range is 5, 10, 20, or 40 NM. Dashed runway centerlines extend 14.2 NM.
	Selected reference point and bearing distance information (G)	MAP, MAP CTR, PLN	Displays the reference point selected on the CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).
	GPS position (W)	MAP, MAP CTR	When the EFIS POS map switch is selected on, indicates GPS position relative to FMC position.
	ADIRU position (W)	MAP, MAP CTR	When the EFIS control panel POS map switch is selected on, the star indicates ADIRU position relative to FMC position.
	Weather radar returns (R, A, G, M)	MAP, MAP CTR, VOR, APP	The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green. Turbulence is displayed in magenta.
	Selected map options (C)	MAP, MAP CTR, PLN	Displays EFIS control panel selected map options.
	MAP source annunciation (G)	MAP, MAP CTR, PLN	Displays source of FMC data used by MDS for data presentation.

SYMBOL	NAME	MODE	REMARKS
	Range arcs (W)	MAP, VOR, APP	Displayed in MAP, APP and VOR modes when the WXR map, TERR map or TCAS TFC switches are selected.
	Weather radar annunciations: Mode (C), Tilt (C), Tilt Mode (C), Gain (C)	MAP, MAP CTR, VOR, APP	Annunciations vary with option selected.

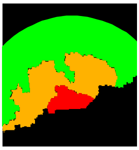
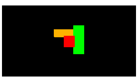
Vertical Situation Display (VSD)

SYMBOL	NAME	REMARKS
	Airplane symbol (W)	Current airplane altitude is the bottom of the triangle. Current airplane lateral position relative to terrain is the point of the triangle.
	Enroute swath (C) (dashed line)	Indicates area of the map that is shown on the VSD. Display is inhibited both on takeoff and approach when the airplane is within 6 NM of the runway and less than 3000 feet above field elevation. During turns, the swath edge leading the turn opens in the direction of the turn.
	Selected altitude bug and line (M)	Bug indicates the altitude set in the MCP altitude window. When the selected altitude is off scale, the bug is parked at the top or bottom, with only one half the bug visible. Dashed line extends from bug to background display boundary. Line does not park.
	BARO minimums pointer and line (G)	Pointer indicates the barometric minimums selected on the EFIS control panel. Dashed line extends from pointer to background display boundary. Pointer and line turn amber when airplane descends below selected minimum altitude. Reset with the RST switch on the EFIS control panel. After the pointer is set with the BARO position, moving the Minimums Reference selector to RADIO displays only the pointer.

SYMBOL	NAME	REMARKS
	Decision gates (W, A)	Indicates suggested points where airplane should be path and speed stable on approach. Gates are placed on the 3 Degree Reference Line or FMC Approach Glide Path Angle Line: • at 1000 feet above field elevation (W). • at 500 feet above field elevation (A). Decision gates that are below the missed approach waypoint altitude will not be displayed.
	Flight path vector (W)	Fixed length line indicates current flight path angle and rotates about the point of the triangle. Angle of the line is dependent on the vertical speed and ground speed of the airplane.
	MCP selected vertical speed vector (M)	Dashed line indicates the selected vertical speed as a target angle when the MCP V/S mode is selected. Extends to the edge of the background display and rotates about the point of the triangle.
	Range to target speed dot (G)	Indicates where the airplane will achieve the FMC or MCP target speed. If the airplane is within 5 knots of the target speed the dot will be blanked. If the airplane increases 10 knots or more faster than the target speed the dot will reappear. Displayed at the end of the Flight Path Vector as an unfilled dot if the target speed will not be achieved within the vector length.

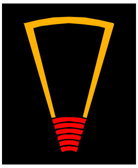
SYMBOL	NAME	REMARKS
	Waypoint altitude constraint: active (M), inactive (W)	At Altitude example.
	Waypoint altitude constraint: active (M), inactive (W)	At or Above Altitude example.
	Waypoint altitude constraint: active (M), inactive (W)	At or Below Altitude example.
	Waypoint altitude constraint: active (M), inactive (W)	Block Altitude example.

Look-Ahead Terrain

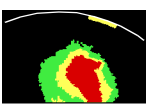
SYMBOL	NAME	MODE	REMARKS
	Terrain display (R, A, G, M)	MAP, MAP CTR, VOR, APP	Displays terrain data from the GPWS terrain data base. Color and density vary based on terrain height vs. airplane altitude. Refer to Chapter 15, Warning Systems.
	Terrain obstacle (R, A, G)	MAP, MAP CTR, VOR, APP	Obstacles are displayed from the GPWS data base and use the same display criteria as the terrain display.
OBSTACLE	Obstacle annunciation (R, A)	All	Obstacle caution alert active (A), obstacle warning alert active (R).
TERR 060 030	Terrain mode annunciation (C) Terrain elevation (R,A,G)	MAP, MAP CTR, VOR, APP	Terrain display enabled (manual or automatic display). Terrain elevation displayed in hundreds of feet showing highest and lowest displayed terrain. Colors correspond to terrain display. Terrain elevation not displayed when terrain data unavailable.
TERR TEST	Terrain test mode annunciation (C)	All	GPWS operating in self-test mode.
TERRAIN	Terrain annunciation (R, A)	All	Look-ahead terrain caution alert active (A), look-ahead terrain warning alert active (R).
TERR FAIL	Terrain status annunciations (A)	All	Look-ahead terrain alerting and display have failed.

SYMBOL	NAME	MODE	REMARKS
TERR POS	Terrain status annunciations (A)	All	Look-ahead terrain alerting and display unavailable due to position uncertainty.
TERR INHIBIT	Terrain status annunciations (A)	All	GPWS terrain inhibit switch in TERR INHIBIT position.
TERR RANGE DISAGREE	Terrain range status annunciations (A)	MAP, MAP CTR, VOR, APP	Terrain output range disagrees with selected EFIS control panel range.
MAP/TERR RANGE DISAGREE	Terrain range status annunciations (A)	MAP, MAP CTR	Terrain output range and map display output range disagree with selected EFIS control panel range.

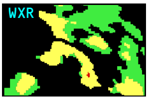
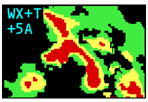
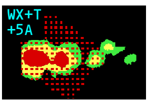
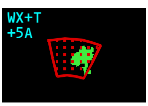
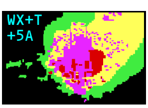
Predictive Windshear

SYMBOL	NAME	MODE	REMARKS
	Predictive windshear symbol (R, B, A)	MAP, MAP CTR, VOR, APP	Displays windshear location and approximate geometric size (width and depth). Amber radials extend from predictive windshear symbol to help identify location of windshear event.
WINDSHEAR	Windshear annunciation (R, A)	All	Predictive windshear caution active (A). Predictive windshear warning active (R).
PWS FAIL	Predictive windshear status annunciation (A)	All	Predictive windshear alerting and display have failed.

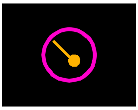
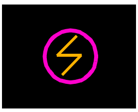
Path Attenuation Compensation (PAC)

	Weather radar Path Attenuation Compensation (A)	MAP, MAP CTR, VOR, APP	Attenuated region behind rainfall (radar shadow) is indicated by amber arc on outer range ring.

Threat Assessment

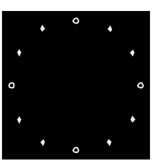
 	Core Threat Assessment (R, A, G, M)	MAP, MAP CTR, VOR, APP	Weather radar colors are adjusted to more accurately reflect the weather threat.
	Associated Threat Assessment (R)		Lightning or hail probability is indicated by red speckled pattern in black/green/amber areas above 25,000 ft, or green/amber areas below 25,000 ft.
	Predictive OverFlight (R)		Rapidly building cell below flight altitude is indicated by red speckled pattern with red outline. Indication is replaced by actual weather when cell reaches flight altitude.
	Two-level Turbulence (M)		Severe turbulence is displayed in solid magenta. Light-to-moderate turbulence is displayed in speckled magenta.

Weather Hazard Displays

SYMBOL	NAME	MODE	REMARKS
	Predictive Hail	MAP, MAP CTR, VOR, APP	Conditions in the associated weather cell are conducive to the development of Hail.
	Predictive Lighting	MAP, MAP CTR, VOR, APP	Conditions in the associated weather cell are conducive to the development of Lighting.
	Rain Echo Attenuation Compensation Technique (REACT)	MAP, MAP CTR, VOR, APP	Indicates areas where the radar signal has been attenuated. These areas are shown as magenta arcs superimposed over the reflectivity in the areas where the signal attenuation is significant. These arcs indicate that there could be severe weather in that area, even though only mild or no reflectivity is shown.

TCAS

SYMBOL	NAME	MODE	REMARKS
■ ↑ -03	TCAS resolution advisory (RA), relative altitude (R)	MAP, MAP CTR, VOR, APP	These symbols are displayed only when the EFIS control panel traffic (TFC) switch is selected on. Refer to Chapter 15, Warning Systems. The arrow indicates traffic climbing or descending at a rate >= 500 fpm. At rates < 500 fpm, the arrow is not displayed. The number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane. The number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane. Absence of the number implies altitude unknown.
+02 ● ↓	TCAS traffic advisory (TA), relative altitude (A)		
◆ ↓ -05	TCAS proximate traffic, relative altitude (W)		
+09 ◇ ↑	TCAS other traffic, relative altitude (W)		
RA 5.3 +03 ↑ TA 8.9 -12 ↑	TCAS no bearing message (RA–R, TA–A)	MAP, MAP CTR, VOR, APP	Message provides traffic type, range in NM, altitude and vertical direction. TFC must be selected on.
TRAFFIC	TCAS traffic alert message (RA–R, TA–A)	All	Displayed whenever a TCAS RA or TA is active. EFIS control panel TFC switch does not have to be selected on.
OFFSCALE	TCAS off scale message (RA–R, TA–A)	MAP, MAP CTR, VOR, APP	Displayed whenever RA or TA traffic is outside the traffic area covered by the ND range. Displayed only if the EFIS control panel TFC switch is selected on.

SYMBOL	NAME	MODE	REMARKS
TFC	TCAS mode (C)	MAP, MAP CTR, VOR, APP	Indicates the ND TCAS display is active; the EFIS control panel TFC switch is selected on.
TA ONLY	TCAS mode (C)	All	Indicates TCAS computer is not computing RAs. Displayed whether the EFIS control panel TFC switch is selected on or off.
TCAS TEST	TCAS mode (C)	All	Indicates TCAS is operating in the test mode. Displayed whether EFIS control panel TFC switch is selected on or off.
TCAS OFF	TCAS mode (A)	All	Displayed when the TCAS/ATC mode switch is not in TA ONLY or TA/RA. Not displayed if TCAS is failed.
TCAS FAIL	TCAS mode (A)	All	Indicates TCAS failure, if traffic is selected.
	Range Ring (W)	MAP, MAP CTR, VOR, APP	Displayed when TFC selected on EFIS Control Panel. Shows 3 NM range ring oriented to aircraft heading. Displayed at ranges of 80 NM or less.

RAAS

SYMBOL	NAME	MODE	REMARKS
ON TAXIWAY	On Taxiway	MAP, MAP CTR, VOR, APP	Airplane is on a surface other than a runway and ground speed is greater than 40 knots.

Flight Management, Navigation — Chapter 11
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Intentionally
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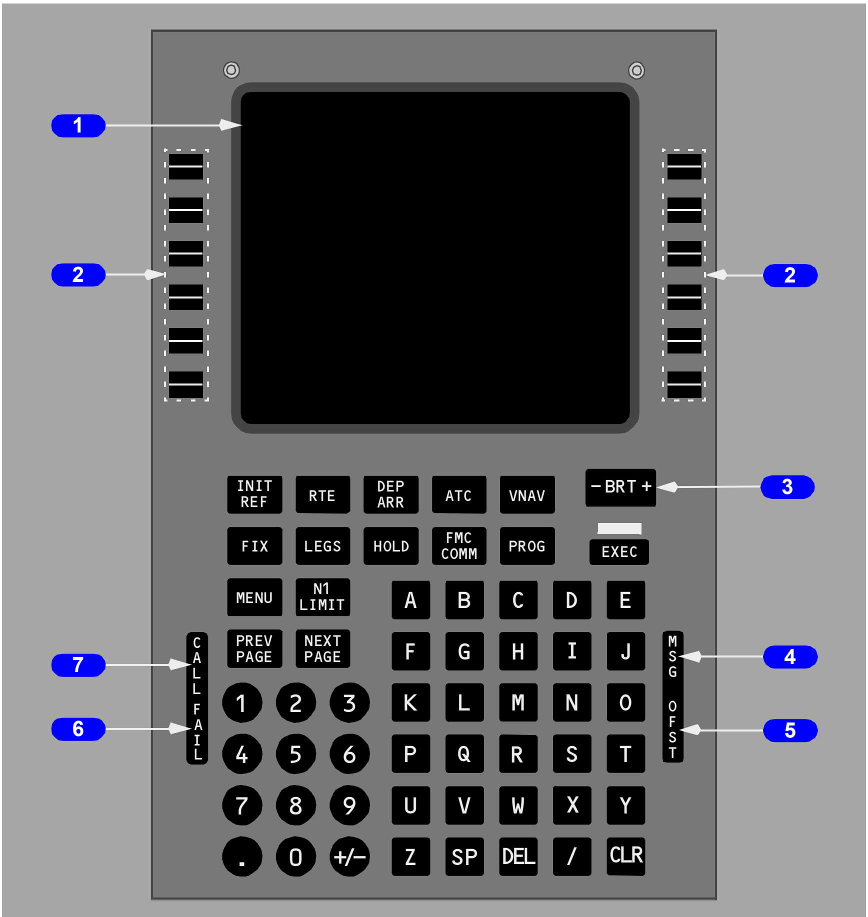
Flight Management System
Control Display Unit (CDU)



FORWARD ELECTRONIC PANEL
(Liquid Crystal Display FANS MCDU)

1 Control Display Unit (CDU) Display

Shows FMS data pages.

2 Line Select Keys

Push –

- moves data from scratchpad to selected line
- moves data from selected line to scratchpad
- selects page, procedure, or performance mode as applicable
- deletes data from selected line when DELETE is shown in scratchpad.

3 Brightness Control

Rocker switch (plus or minus) - controls display brightness.

4 Message (MSG) Light

Illuminated (white) – scratchpad message is shown.

5 Offset (OFST) Light

Illuminated (white) – LNAV gives guidance for lateral route offset.

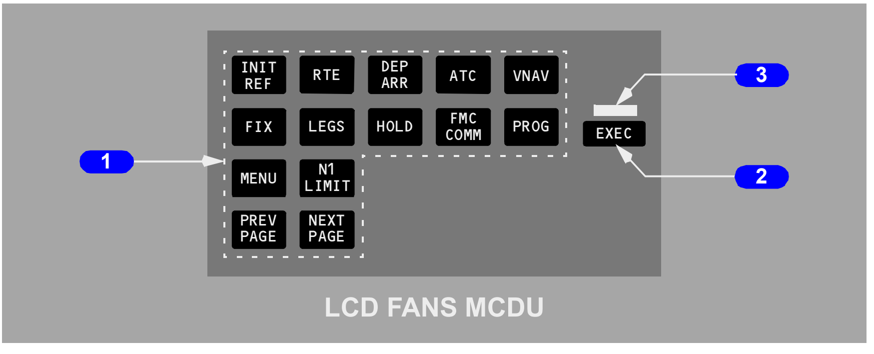
6 FAIL Light

Illuminated (amber) for test purposes only. The MCDU FAIL lamp will not illuminate for an FMC failure.

7 CALL Light

Illuminated (white) – a subsystem other than the FMC is requesting control of the CDU.

Function and Execute Keys



1 CDU Function Keys

Push –

- INIT REF – shows page for data initialization or for reference data
- RTE – shows page to input or change origin, destination, or route

- DEP ARR – shows page to input or change departure and arrival procedures
- ATC – displays appropriate ATC page (as installed).
- VNAV –
  - shows currently active performance page (CLB, CRZ, DES)
  - CLB page is displayed if no active phase exists
- FIX – shows page to create reference points on map display
- LEGS –
  - shows page to evaluate or modify lateral and vertical route data
  - shows page to control PLAN mode display
- HOLD – shows page to create holding patterns and show holding pattern data
- FMC COMM – displays FMC COMM status page.
- PROG – shows page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
- MENU – shows page to choose subsystems controlled by CDU
- N1 LIMIT – shows page to view or change N1 thrust limits
- PREV PAGE – shows previous page of related pages (for example, LEGS pages)
- NEXT PAGE – shows next page of related pages.

2 Execute (EXEC) Key

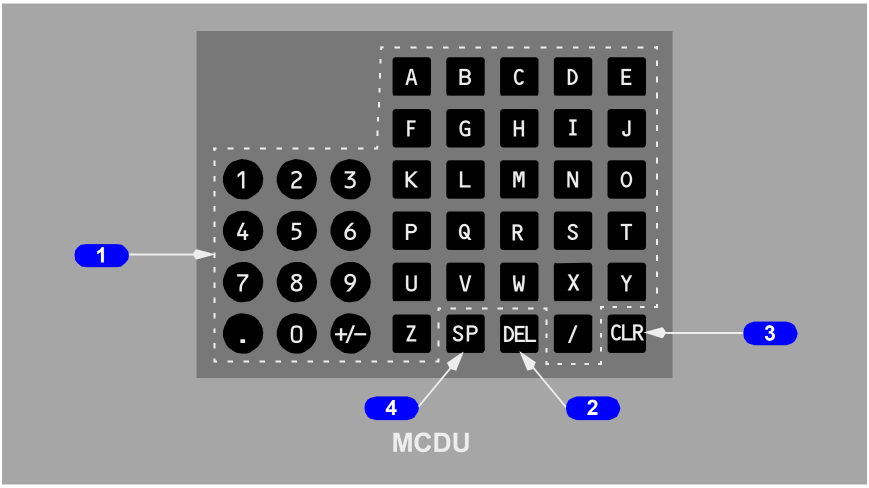
Push –

- makes data modification(s) active
- extinguishes execute light.

3 Execute Light

Illuminated (white) – active data is modified but not executed.

Alpha/Numeric and Miscellaneous Keys



1 Alpha/Numeric Keys

Push –

- puts selected character in scratchpad
- Slash (/) key – puts "/" in scratchpad
- Plus Minus (+/–) key – first push puts "–" in scratchpad. Subsequent pushes alternate between "+" and "–".

2 Delete (DEL) Key

Push – puts DELETE in scratchpad.

3 Clear (CLR) Key

Push –

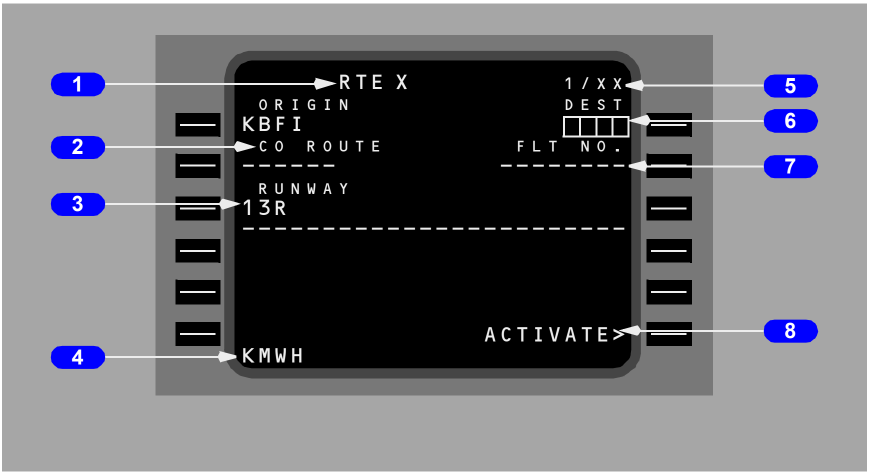
- clears the last scratchpad character
- clears scratchpad message.

Push and hold – clears all scratchpad data.

4 Space (SP) Key

Push – puts space in scratchpad.

CDU Page Components



1 Page Title

Subject or name of data shown on page.

ACT (active) or MOD (modified) shows whether page contains active or modified data.

2 Line Title

Title of data on line below.

3 Line

Shows –

- prompts
- selections
- options
- data.

4 Scratchpad

Shows messages, alpha–numeric entries or line selected data.

5 Page Number

Left number is page number. Right number is total number of related pages.

6 Boxes

Data input is mandatory.

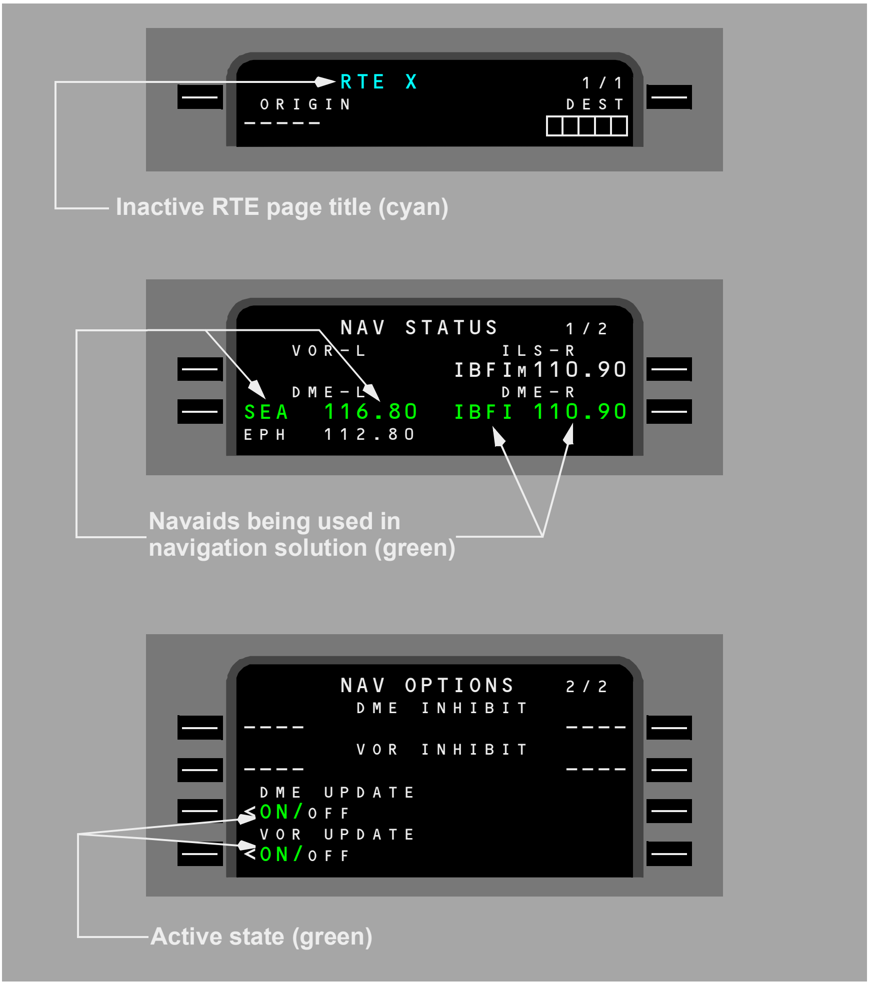
7 **Dashes**

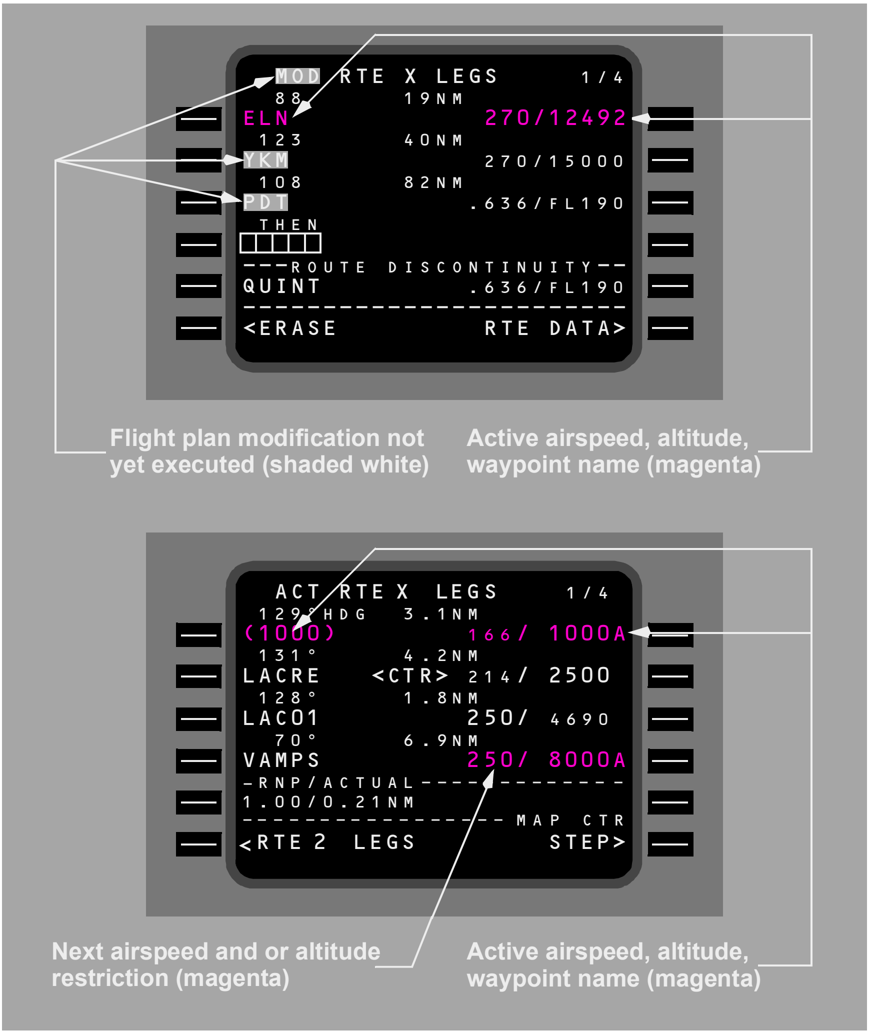
Data input is optional. The data is not mandatory.

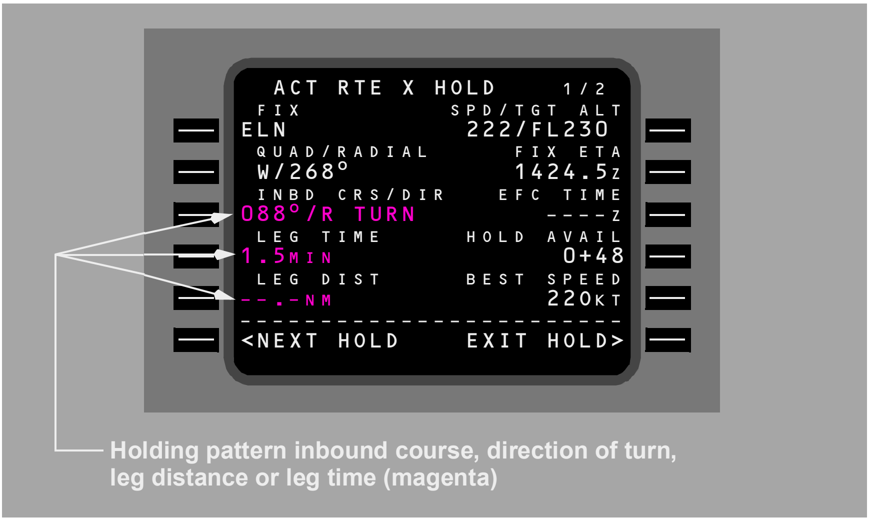
8 **Prompts**

Show pages, select modes, and control displays. Caret “<” or “>” is before or after prompt.

CDU Page Color



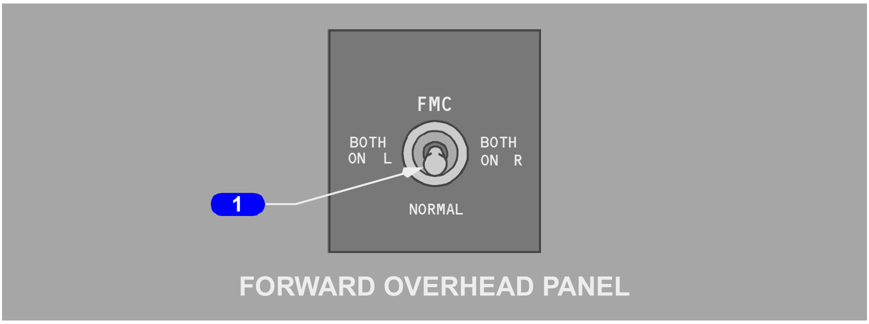

MOD RTE X LEGS 1/4
88 19NM
ELN 270/12492
123 40NM
YKM 270/15000
108 82NM
PDT .636/FL190
THEN
---ROUTE DISCONTINUITY--
QUINT .636/FL190
<ERASE RTE DATA>
Flight plan modification not yet executed (shaded white)
Active airspeed, altitude, waypoint name (magenta)
ACT RTE X LEGS 1/4
129° HDG 3.1NM
(1000) 166/ 1000A
131° 4.2NM
LACRE <CTR> 214/ 2500
128° 1.8NM
LAC01 250/ 4690
70° 6.9NM
VAMPS 250/ 8000A
-RNP/ACTUAL
1.00/0.21NM
MAP CTR
<RTE 2 LEGS STEP>
Next airspeed and or altitude restriction (magenta)
Active airspeed, altitude, waypoint name (magenta)



Color is used as follows:

- black – background color of page
- cyan –
  •inactive RTE, RTE LEGS and RTE HOLD page titles
- green –
  •actively tuned VOR, ILS, or DME data (frequency, station ID, course)
  •active state of two–position and three–position selectors.
- magenta – data used by FMC for lateral and vertical flight commands
  •active waypoint
  •active airspeed
  •active altitude
  •holding pattern inbound course, direction of turn, and leg time or leg distance
  •speed and or altitude restrictions targeted next, restriction may be several waypoints down the route from the active waypoint
- shaded white –
  •modifications
  •MOD precedes page titles of modified pages
- white – most data

FMC Source Select Switch



1 **FMC Source Select Switch**

BOTH ON L –

- selects left FMC for all FMC operations
- right map will annunciate “FMC L.”

NORMAL –

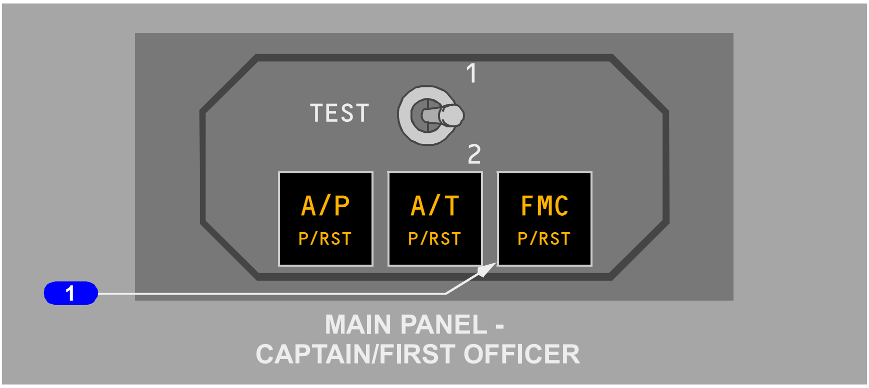
- left FMC controls CDUs and provides input to the autothrottle system
- right FMC operates in synchronization with left FMC
- maps display composite information from both FMCs

BOTH ON R –

- selects right FMC for all FMC operations
- left map will annunciate “FMC R.”

Note: Moving the source select switch will cause LNAV and VNAV to disengage.

FMC Alert Light



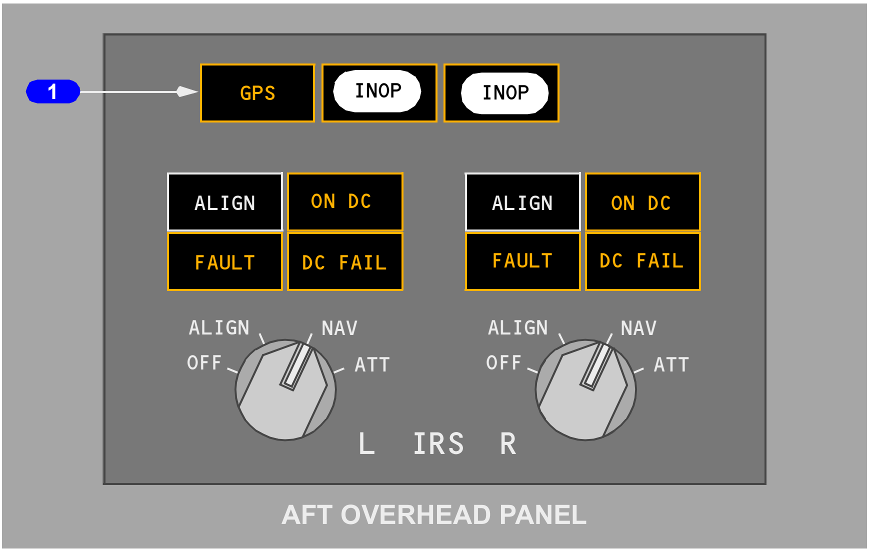
1 FMC Alert Light

Illuminated (amber) –

- an alerting message exists for both CDUs, or
- test switch is in position 1 or 2.
- "USING RSV FUEL" alerting mesage displayed on the Engine Display and CDU scratchpads.
- "INSUFFICIENT FUEL" alerting mesage displayed on the Engine Display and CDU scratchpads.
- "FUEL DISAGREE" alerting mesage displayed on the Engine Display and CDU scratchpads.

Push – both pilots' FMC alert lights extinguish.

Global Positioning System (GPS) Light

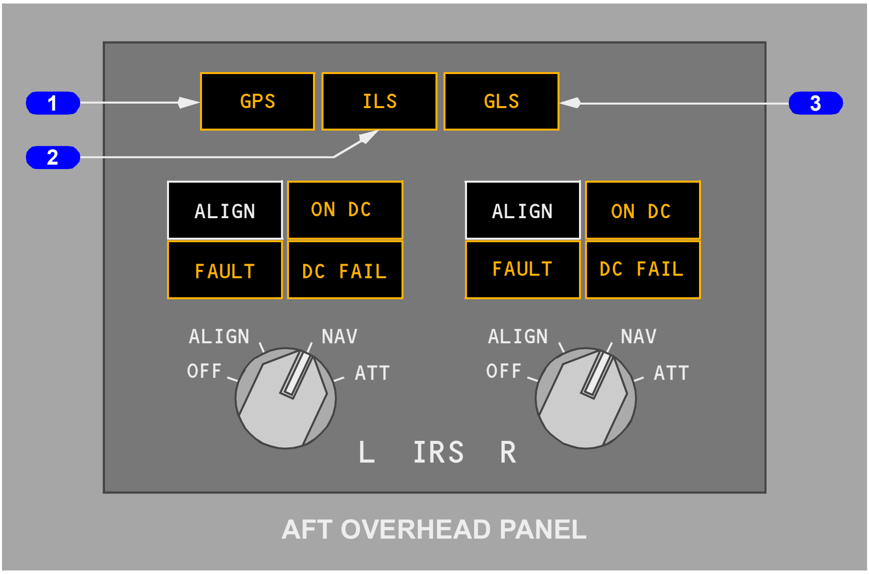


1 Global Positioning System (GPS) Light

Illuminated (amber) –

- indicates failure of both GPS sensor units
- indicates failure of a single GPS sensor unit when either system annunciator panel is pushed to initiate a recall
- with single GPS sensor failure, light extinguishes when the system recall is reset.

Landing System Lights



1 Global Positioning System (GPS) Light

Illuminated (amber) –

- indicates failure of both GPS sensor units
- indicates failure of a single GPS sensor unit when either system annunciator panel is pushed to initiate a recall
- with single GPS sensor failure, light extinguishes when the system recall is reset.

2 Instrument Landing System (ILS) Light

Illuminated (amber) –

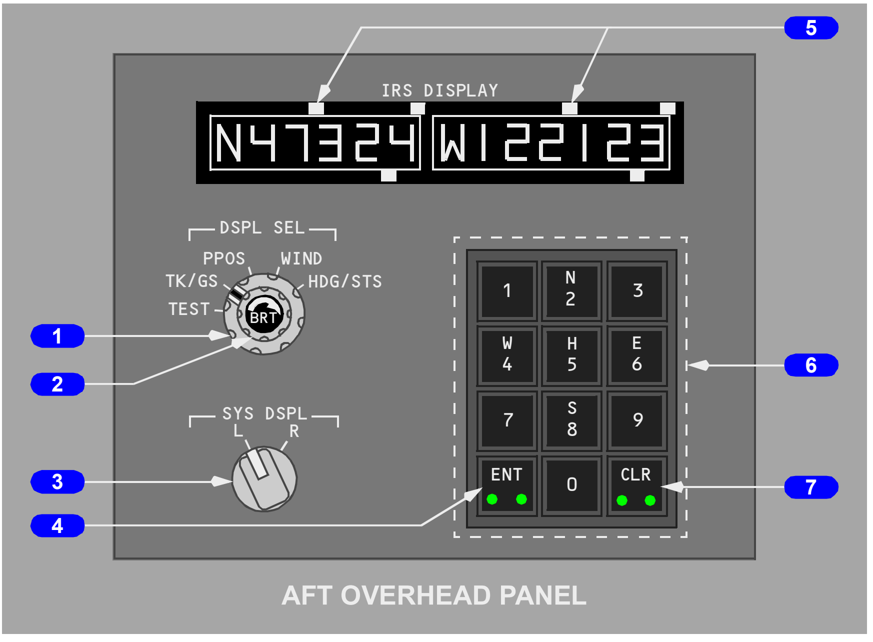
- indicates failure of both ILS sensor units
- indicates failure of a single ILS sensor unit when either system annunciator panel is pushed to initiate a recall
- with single ILS sensor failure, light extinguishes when the system recall is reset.

3 GNSS Landing System (GLS) Light

Illuminated (amber) –

- indicates failure of both GLS sensor units.
- indicates failure of a single GLS sensor unit when either system annunciator panel is pushed to initiate a recall.
- with single GLS sensor failure, light extinguishes when the system recall is reset.

Inertial System
IRS Display Unit (ISDU)



1 Display Selector (DSPL SEL)

TEST (spring–loaded to TK/GS) –

- all lights in data displays and on the mode selector unit momentarily illuminate, followed by a 10 second self–test
- use only during alignment.

TK/GS –

- left window displays true track (course)
- right window displays present ground speed (knots).

PPOS –

- left window displays present latitude
- right window displays present longitude.

WIND –

- left window displays present inflight true wind direction
- right window displays present inflight wind speed (knots).

HDG/STS –

- left window displays present true heading
- right window displays any applicable maintenance status codes
- during alignment, right window displays minutes remaining until alignment is complete. For alignments greater than 15 minutes, the window displays 15 until the time remaining reaches 14 minutes. The display then counts down in one minute intervals.

2 Brightness (BRT) Control

Rotate – adjusts brightness of the data displays.

3 System Display (SYS DSPL) Selector

L – selects left IRS for the data displays.

R – selects right IRS for the data displays.

4 Enter (ENT) Key

Illuminated (white) – N, S, E, W, or H entries are being keyed.

Push – keyed data is entered into IRS following completion of valid self–test for reasonableness.

5 Data Displays

Two windows display data for the IRS selected with the system display selector

- type of data displayed is normally determined by the display selector
- keyboard entry of present position or magnetic heading overrides the selected display
- last digit of each window is for a decimal place (tenths).

6 Keyboard

Push –

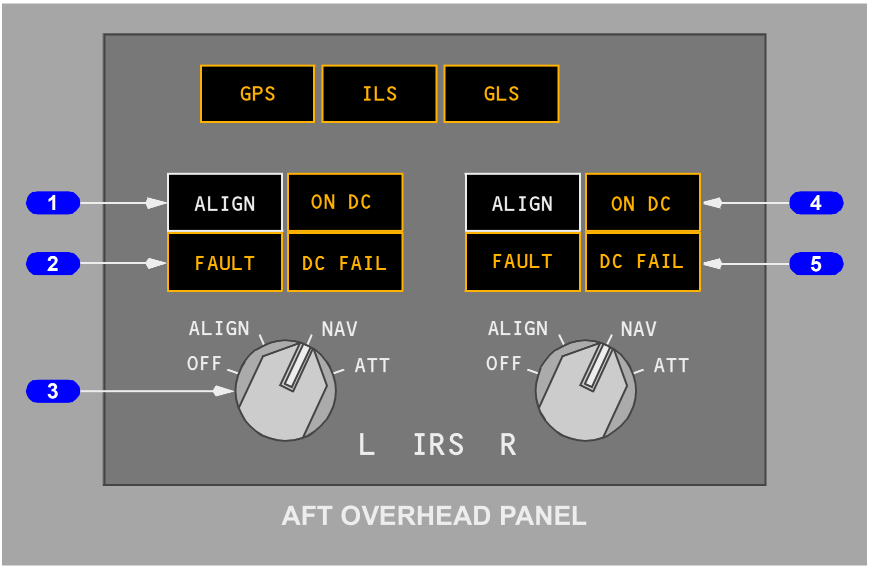
- alpha keys:
  - data displays are controlled by the keyboard when the N, S, E, W (latitude/longitude) or H (heading) keys are pushed
  - pushing an alpha key arms the keyboard for numeric entries.
- numeric keys:
  - permit manual entry of present position when ALIGN light is illuminated
  - permit manual entry of magnetic heading when either mode selector is in ATT.

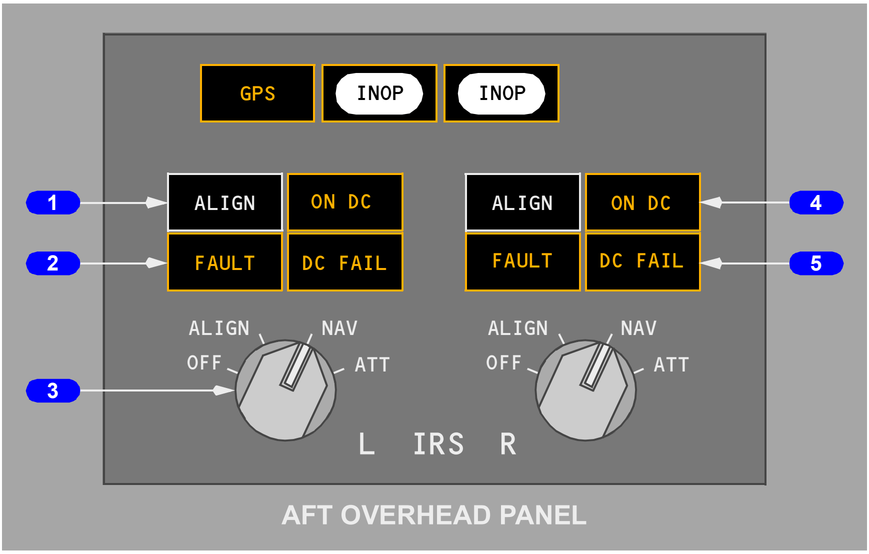
7 Clear (CLR) Key

Illuminated (white) – an ENT attempt has failed (entry not accepted by IRS).

Push – clears data display of any data not yet entered or accepted. If illuminated, cue lights extinguish.

IRS Mode Selector Unit





1 ALIGN Light

Illuminated (white) –

- steady – the related IRS is operating in the ALIGN mode, the initial ATT mode, or the shutdown cycle
- flashing – alignment cannot be completed due to IRS detection of:
  - significant difference between previous and entered positions or an unreasonable present position entry
  - no present position entry.

Extinguished –

- IRS not in ALIGN mode
- with mode selector in NAV, alignment is complete, and all IRS information is available
- with mode selector in ATT, attitude information is available. Heading information is available following entry of initial magnetic heading.

2 FAULT Light

Illuminated (amber) – a system fault affecting the related IRS ATT and/or NAV modes has been detected.

3 Inertial Reference System (IRS) Mode Selector

OFF –

- alignment is lost
- all electrical power is removed from the system after a 30 second shutdown cycle.

ALIGN –

- rotating the selector from OFF to ALIGN initiates the alignment cycle
- rotating the selector from NAV to ALIGN automatically updates alignment and zeroes ground speed error.

NAV (detented position) –

- system enters the NAV mode after completion of the alignment cycle and entry of present position
- in NAV mode, all IRS information is available to airplane systems for normal operations.

ATT – provides only attitude and heading information:

- attitude information is invalid (attitude flag in view) until ALIGN light is extinguished
- heading information is invalid (heading flags in view) until the actual magnetic heading is manually entered after the ALIGN light is extinguished
- position and ground speed information is not available until the IRS is aligned on the ground
- the selector must be cycled to OFF before reselecting ALIGN or NAV.

4 ON DC Light

Illuminated (amber) –

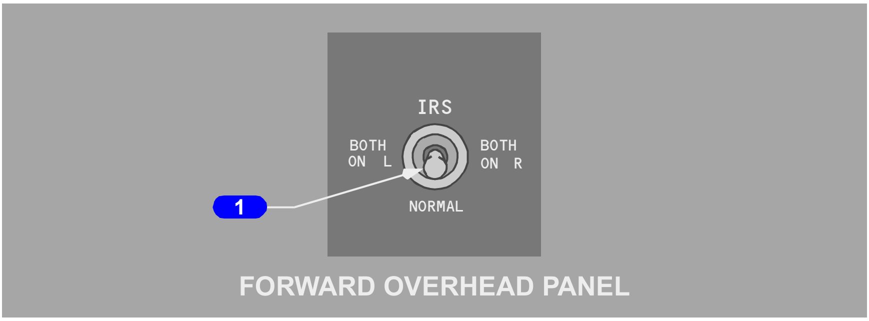
- the related IRS is operating on DC power from the switched hot battery bus (AC power not normal)
- if on the ground, the ground–call horn in the nose wheel well sounds, providing an alert that a battery drain condition exists
- momentary illumination is normal during alignment self–test.

5 DC FAIL Light

Illuminated (amber) –

- DC power for the related IRS is not normal
- if the other lights are extinguished, the IRS is operating normally on AC power.

IRS Transfer Switch



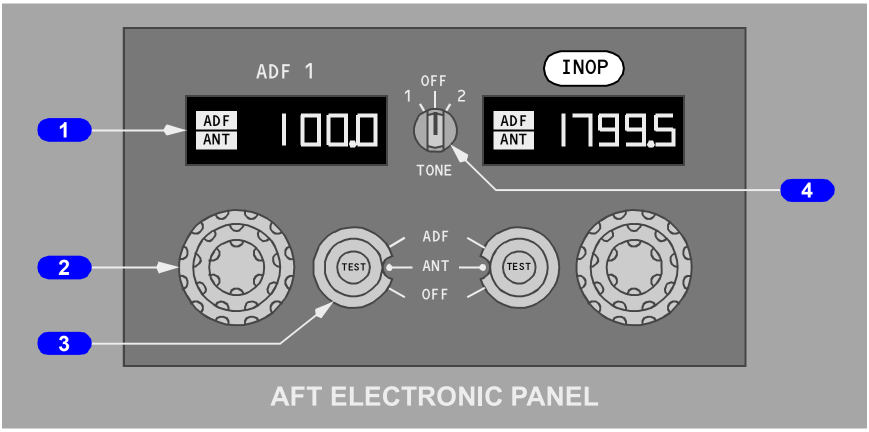
1 Inertial Reference System (IRS) Transfer Switch

BOTH ON L – switches the flight instruments attitude and heading source to left IRS.

NORMAL – flight instruments attitude and heading source is from default IRS.

BOTH ON R – switches the flight instruments attitude and heading source to right IRS.

Radio Navigation Systems
Automatic Direction Finding (ADF) Control



1 Frequency Indicator

Shows the frequency selected with the related frequency selector.

Shows if the system is in the ADF or antenna (ANT) mode.

2 Frequency Selector

Rotate –

- outer knob sets the hundreds number
- middle knob sets the tens number
- inner knob sets the tenths and ones number.

3 Mode Selector Switch

ADF –

- audio reception possible
- ADF bearing sent to the DUs.

ANT –

- audio reception optimized
- no ADF bearing data available.

OFF – removes power from selected receiver.

TEST – tests related ADF bearing pointers and warning flags on the DUs.

- DU ADF indications:
  - show ADF fail flag and ADF bearing pointer goes out of view
  - ADF fail flag goes out of view and ADF bearing pointer remains out of view
  - ADF bearing pointer slews to 135 degrees relative bearing.

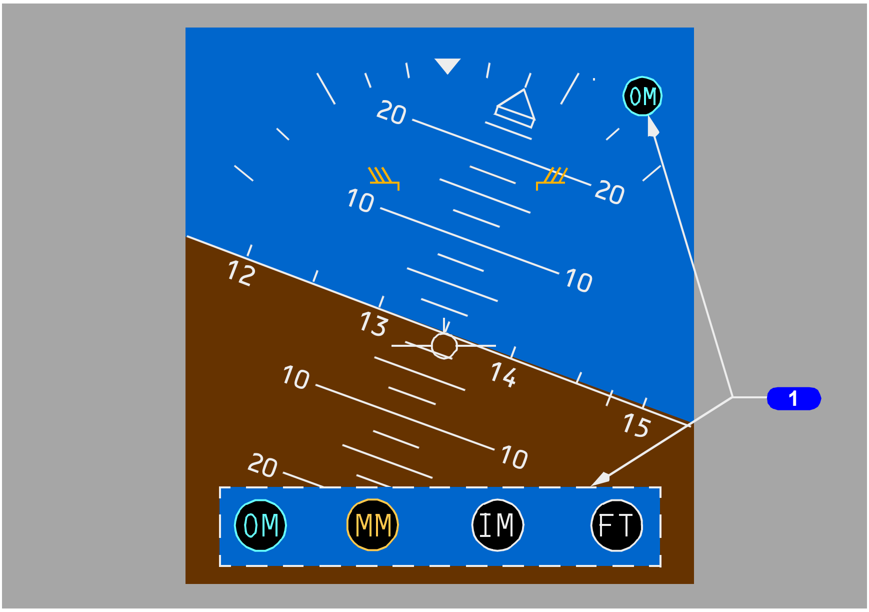
4 TONE Switch

1 – adds tone to ADF receiver No. 1 audio.

2 – inoperative.

OFF – disables tones.

Marker Beacon Annunciations



1 Marker Beacon Lights

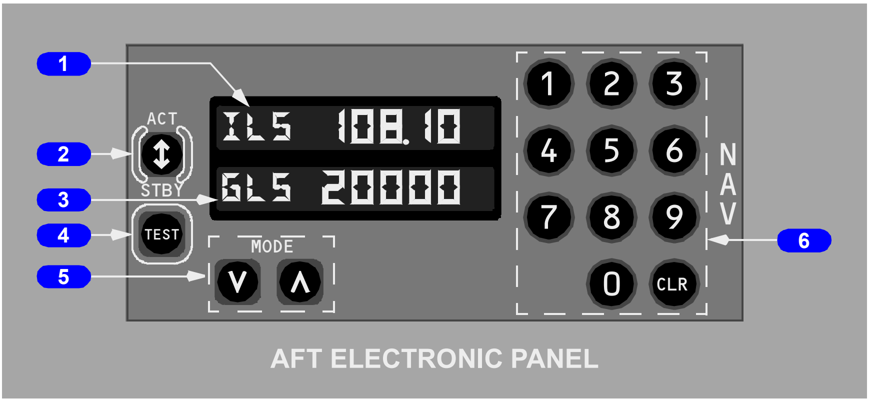
OM (cyan) – illuminates over an outer marker beacon.

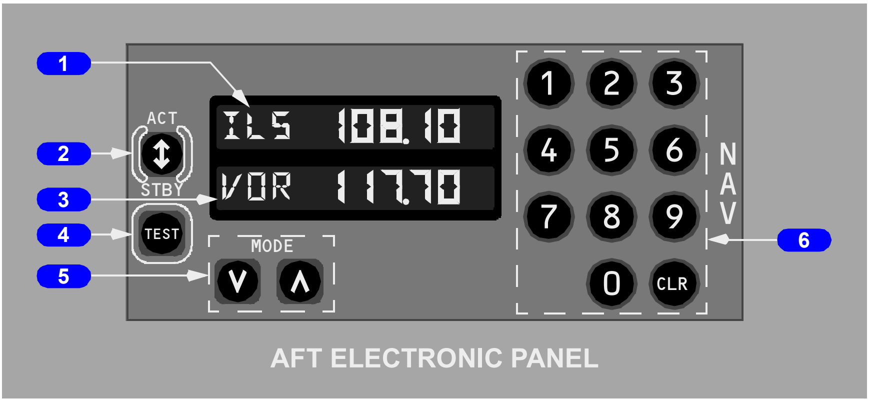
MM (amber) – illuminates over a middle marker beacon.

IM (white) – illuminates over an inner marker beacon.

FT (white) – illuminates during self test.

Multi-Mode Navigation Control





1 Active (ACT) Mode and Frequency Indicator

Indicates the active mode and frequency.

2 Transfer Switch

Push – standby mode and frequency moved to active indicator window; active mode and frequency moved to standby indicator window.

3 Standby (STBY) Mode and Frequency Indicator

Indicates the standby mode and frequency.

4 TEST Switch

With a VOR frequency tuned and a course of 000 selected:

- shows VOR fail flag
- deviation bar biases out of view and then returns to centered position
- bearing pointer slews to 180 degrees
- DME displays:
  - DME fail flag
  - dashes
  - normal DME distance.

With a ILS frequency tuned and a course within 90 degrees of airplane heading:

- pointers disappear and LOC and G/S flags appear momentarily
- pointers appear and display one dot up and one dot left
- pointers then display one dot low and one dot right
- pointers then return to normal display

- DME displays:
  - DME fail flag
  - dashes
  - normal DME distance.

With a GLS (as installed) frequency tuned and a course within 90 degrees of airplane heading:

- pointers disappear and LOC and G/S flags appear momentarily
- pointers appear and display one dot up and one dot left
- pointers then display one dot low and one dot right
- pointers then return to normal display.

Note: DME is not tested with GLS and no indications will be displayed.

5 Mode Switches

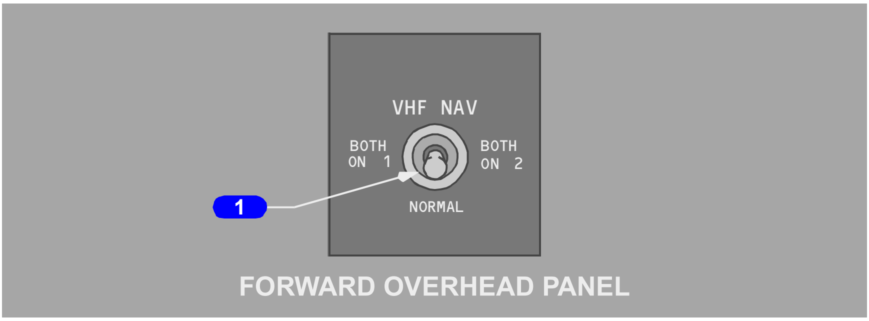
Push – manually inserts ILS, VOR or GLS into the standby indicator window.

6 Frequency Selection Keypad

Push – manually selects the standby frequency.

CLR – clears the standby frequency.

VHF NAV Transfer Switch



1 VHF NAV Transfer Switch

The VHF NAV transfer switch changes the source of the data that the DPCs use for the navigation displays. The switch transfers the following data: DME, ILS/GLS, VOR, and MCP course.

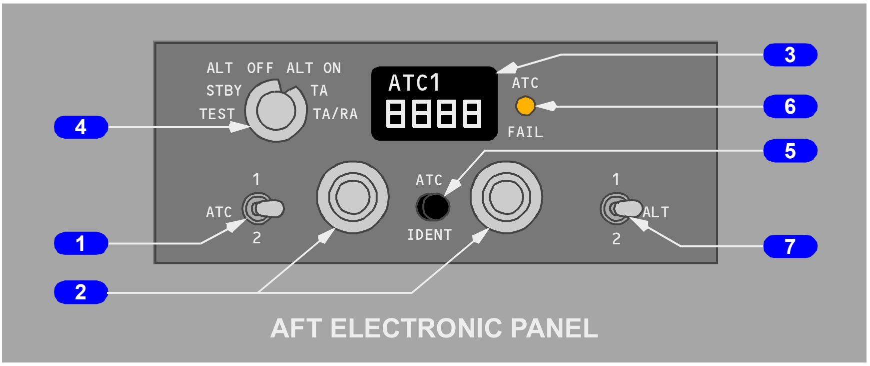
BOTH ON 1 – the DPCs use Multimode Receiver 1 as the source for the captains display and first officers display.

NORMAL – Multimode Receiver 1 supplies data for the captains display and Multimode Receiver 2 supplies data for the first officers display.

BOTH ON 2 – the DPCs use Multimode Receiver 2 as the source for the captains display and first officers display.

Note: The Digital Flight Control System cannot use VOR/ILS data that is not shown on the displays. Thus, when the Autopilot (A/P) system is engaged the VHF Navigation Control must match the primary Autopilot system that is ENGAGED for proper ILS/VOR operations; i.e. (CMD A uses VHF NAV 1 for control and CMD B uses VHF NAV 2 for control).

Transponder Panel



1 Transponder (ATC) Selector

1 – selects transponder No. 1.

2 – selects transponder No. 2.

2 Air Traffic Control (ATC) Code Selector

Rotate – sets transponder code in transponder.

3 Air Traffic Control (ATC) Code Indicator

Shows transponder code.

Shows operating transponder (1 or 2).

4 Transponder Mode Selector

TEST – starts ATC transponder functional test.

STBY (standby) – does not transmit.

ALT (altitude reporting) OFF – transponder operates without altitude reporting.

ALT (altitude reporting) ON – transponder operates with altitude reporting.

TA(traffic advisory) and TA/RA (traffic advisory/resolution advisory) – Refer to Chapter 15, Warning Systems.

5 **Identification (IDENT) Switch**

Push – transmits an identification signal.

6 **Transponder (ATC) FAIL Light**

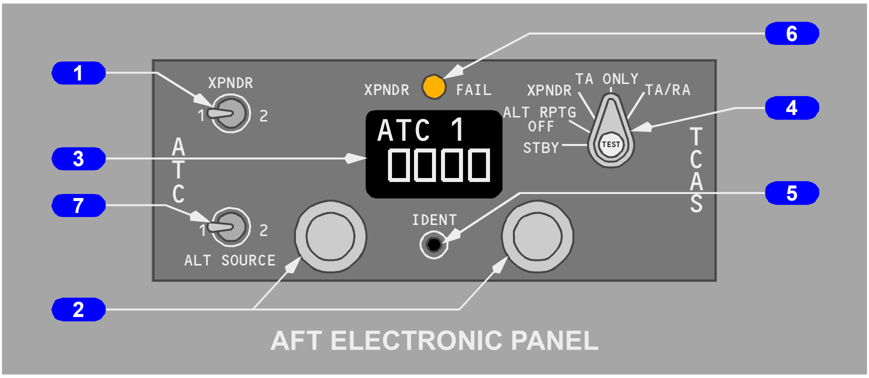
Illuminated (amber):

- indicates transponder malfunction or
- ADS-B inoperative.

7 **Altitude (ALT) Selector**

1 – enables altitude reporting from air data computer No. 1.

2 – enables altitude reporting from air data computer No. 2.



1 **Transponder (XPNDR) Selector**

1 – selects transponder No. 1.

2 – selects transponder No. 2.

2 **Air Traffic Control (ATC) Code Selector**

Rotate – sets transponder code in transponder.

3 **Air Traffic Control (ATC) Code Indicator**

Shows transponder code.

Shows operating transponder (1 or 2).

4 **Transponder Mode Selector**

TEST – starts ATC transponder functional test.

STBY (standby) – does not transmit.

ALT RPTG (altitude reporting) OFF – transponder operates without altitude reporting.

XPNDR (transponder) – transponder operates with altitude reporting.

TA (traffic advisory) ONLY, and TA/RA (traffic advisory/resolution advisory) – Refer to Chapter 15, Warning Systems.

5 Identification (IDENT) Switch

Push – transmits an identification signal.

6 Transponder (XPNDR) FAIL Light

Illuminated (amber):

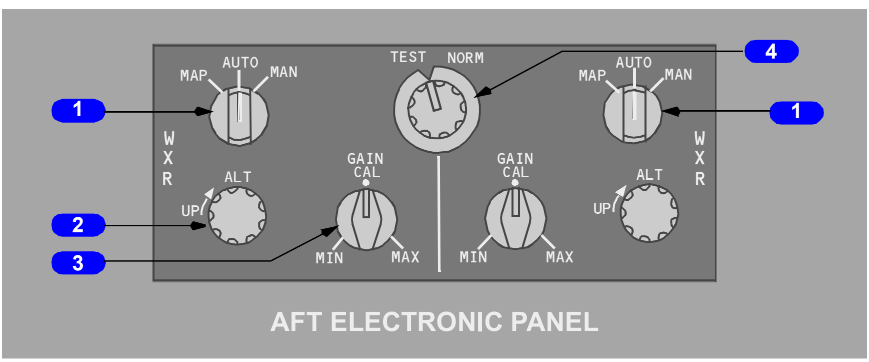
- indicates transponder malfunction or
- ADS-B inoperative.

7 Altitude (ALT) SOURCE Selector

1 – enables altitude reporting from air data computer No. 1.

2 – enables altitude reporting from air data computer No. 2.

Weather Radar Panel



1 **MODE SELECTOR**

- MAP – displays full coverage ground map.
- AUTO – automatic weather presentation mode provides display of windshear out to 5 nm, turbulence out to 60 nm and weather out to 320 nm. Secondary weather returns are shown with black stripes through them. Hazard Displays for lightning, hail, and Rain Echo Attenuation Compensation Technique (REACT) indications will be shown also.
- MAN – manual constant altitude (Weather Analysis) mode. The altitude slice defaults to current altitude upon MAN selection.

Note: In both AUTO and MAN mode of operation, the weather radar automatically increases the gain as the aircraft passes into the freezing layer to help compensate for the decrease in radar reflectivity in this area.

2 **MANUAL ALTITUDE CONTROL**

- ALT – controls weather analysis altitude from 0 to 60,000 ft. MSL in increments of 1000 ft. Selected altitude is shown on the Electronic Flight Display. Active when MAN mode selected.

3 **GAIN CONTROL**

- CAL – rotate to the CAL position for automatic gain control. The CAL position results in a calibrated map or weather radar display. Gain control does not affect turbulence or windshear.
- Manual – rotating the knob out of CAL varies gain between MIN and MAX. VAR is shown on the display, indicating that the gain has been changed from the calibrated position.
- MIN – position reduces gain approximately 16 dBz below the CAL setting.. Rotating the selector toward min reduces precipitation intensity thresholds, requiring greater intensity precipitation levels to display in red.
- MAX – position increases gain 10 dBz over the CAL setting. Rotating the selector toward max increases precipitation intensity thresholds allowing lesser intensity precipitation levels to display in red. max gain should only be used at cruise altitudes to help see less reflective frozen storm tops.

Note: The GAIN knob can also be used to temporarily suppress the display of Hazard Icons and Turbulence Indications by moving the GAIN knob out of the CAL position.

4 SYSTEM CONTROL

- NORMAL – normal weather operation.

Note: When WXR is not selected on the display system, no radar display is shown. While in the air, or on the ground when the radar has been auto-activated (engine throttles at a take-off position setting), the radar will never the less continue to operate, constantly updating the 3D memory so that current radar data is immediately available whenever WXR is selected.

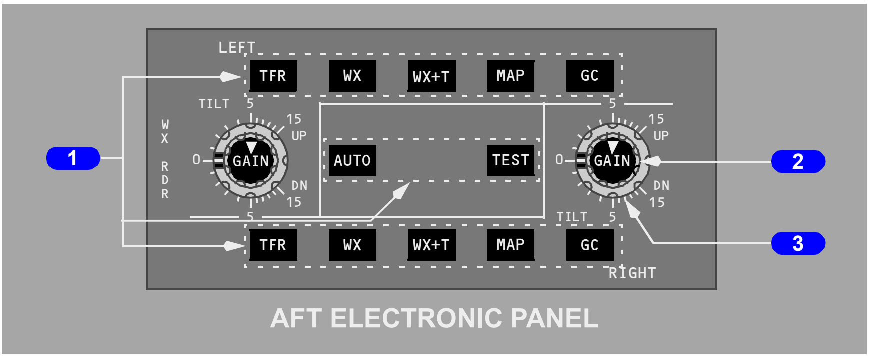
Note: Automatic Windshear Activation – The Windshear mode will automatically be turned on under the following specific aircraft condition: in the air below 1800 ft. AGL or on the ground with the engine throttles at a take-off position setting. See Section 11.20 for Predictive Windshear (PWS) Detection explanation.

- TEST – with WXR selected on at least one EFIS Control panel, places radar system in test mode. When selecting TEST, weather radar panel lighting increases to full bright, dims, then returns to the brightness setting selected prior to selecting TEST

Note: While on the ground, the system test will also exercise the windshear aural and visual alerts shortly after being selected. If the system control is placed in TEST while in flight, the display will show the test pattern, but no windshear aural or visual alerts will be annunciated. If a windshear event is detected while in the test mode, the display will switch to weather with the windshear icon overlaid, and warning or caution annunciations will be triggered, as appropriate.

Time TEST Selected	Approximately 2 Seconds	Approximately 4 Seconds	Approximately 6 Seconds
PWS FAIL/INOP	On	OFF ("ON" if failure detected)	
PWS VISUAL ALERTS	Off	Amber WINDSHEAR on both NDs	Red WINDSHEAR on both NDs and PFDs
PWS AURAL ALERTS	None	Tone "Monitor Radar Display"	"Go Around, Windshear Ahead, Windshear Ahead, Windshear Ahead"
DISPLAY	Normal Test Pattern (No PWS Icon)		

No fault indications shown after completion of the test sequence indicates full radar system operation is available.



1 Weather Radar Mode Switches

Push – selects mode. Left mode switches control the Captain's radar display, right mode switches control the First Officer's radar display.

- TFR (transfer) – transfers other radar display selections to related map.

  Note: Selecting both TFR switches at the same time results in the TEST mode test pattern being displayed until one of the TFR switches is deselected.

- WX – displays weather radar returns without threat information.
- WX+T (threat) – displays: weather radar returns and turbulence in manual mode and weather radar returns and threats in auto mode. Turbulence is displayed out to 40 nm for all selected ranges.

  Note: The WX+T switch must be selected and the WXR set to (AUTO) mode to show core, associated and path threat assessment, as well as level 2 turbulence and predictive overflight protection.

  Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.

- MAP – displays both ground and weather returns without turbulence information.
- GC – temporarily displays ground clutter when radar is in auto mode.
- AUTO – activates the weather radar in multiscan mode:
  - both Captain’s and First Officer’s displays are updated simultaneously
  - tilt is automatically controlled
  - ground clutter may be temporarily displayed by pushing the GC switch
  - the weather radar automatically increases gain as outside air temperature decreases
  - significantly more gain is available in AUTO than in MAN, if the GAIN knob is turned to MAX while in AUTO mode the weather radar will use an additional amount of gain that is not available in MAN mode.
- TEST –
  - activates test mode for both left and right displays
  - transmitter is enabled for less than one second and then muted for the remainder of test
  - displays test pattern and any fault messages on navigation display MAP, center MAP, VOR, and APP modes, with WXR selected.

    Note: If the airplane is on the ground and the thrust levers are not advanced for takeoff, WXR tests the predictive windshear system (PWS) indications. These include PWS caution, PWS FAIL, and PWS warning. Deactivating WXR on the EFIS control panel will discontinue the test. The PWS test lasts approximately 15 seconds and completion is indicated with an oral notification.

2 GAIN Control

CAL (calibrated) gain – is selected when the triangle is at the 12 o’clock position.

Rotate clockwise – from the CAL position increases gain in WX, WX+T and MAP modes.

Rotate counterclockwise – from the CAL position decreases gain in WX, WX+T and MAP modes.

There is no EFIS indication for CAL gain because CAL gain is the standard gain setting. The EFIS will display "VAR" when gain is moved above or below the CAL gain position.

During automatic operation, the MultiScan radar provides Gain PLUS, which includes: (Refer to Section 11.20 for expanded description)

- conventional increase and decrease of receiver sensitivity
- the weather radar automatically increasing gain as outside air temperature decreases
- Path Attenuation Compensation (PAC) Alert
- Oceanic Weather Reflectivity Compensation
- OverFlight Protection
- Predictive OverFlight (With WX+T selected)
- Associated Threat Function (With WX+T selected)
- Core Threat Adjustment (With WX+T selected)
- Two-Level Turbulence Detection (With WX+T selected)
- Flight Path/Descent Assessment

3 TILT Control

During Automatic mode operation, the TILT controls are not active.

When AUTO is selected, an A shows on the EFIS by the tilt angle. When operating in Manual mode M shows.

Rotate clockwise – radar antenna tilts up to selected degrees from horizon.

Rotate counterclockwise – radar antenna tilts down to selected degrees from horizon.

Note: When the WXR system is first powered up (either through initial airplane power, WXR circuit breaker closure or following an extended power interrupt) the indicated tilt will temporarily show the manual tilt setting or zero Auto “0A”. This is a normal condition while the system goes through initial power up built in test (PBIT) and determines the appropriate tilt angle based on current location, altitude and flight path.

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Flight Management, Navigation — Chapter 11
Navigation Systems Description — Section 20

Introduction

Navigation systems include the flight management system (FMS); global positioning system (GPS); air data inertial reference system (ADIRS); radio navigation systems (ADF, DME, ILS, marker beacons, and VOR); ATC transponder; and weather radar. The FMS is described in the Flight Management System Description section of this chapter.

Flight Management System

The flight management system (FMS) is comprised of the following components:

- flight management computer system (FMCS)
- autopilot/flight director system (AFDS)
- autothrottle (A/T)
- inertial reference systems (IRS)
- global positioning system (GPS).

Each of these components is an independent system, and each can be used independently or in various combinations. The term FMS refers to the concept of joining these independent components together into one integrated system which provides continuous automatic navigation, guidance, and performance management.

The integrated FMS provides centralized flight deck control of the airplane's flight path and performance parameters. The flight management computer, or FMC, is the heart of the system, performing navigational and performance computations and providing control and guidance commands.

The primary flight deck controls are the AFDS MCP, two control display units (CDU's), two electronic flight instrument system (EFIS) control panels, and an FMC source selector switch. The primary displays are the CDUs, outboard display units, inboard display units, and upper display unit.

The FMC uses crew entered flight plan information, airplane systems data, and data from the FMC navigation database and performance database to calculate airplane present position, and pitch, roll, and thrust commands required to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route information are sent to the respective pilot's navigation displays. The EFIS control panels are used to select the desired information for navigation display. The mode control panel is used to select the autothrottle, autopilot, and flight director operating modes.

Global Positioning System (GPS)

Two GPS sensors in the Multi-Mode Receivers (MMRs) receive GPS satellite signals. The left and right GPS sensors are independent and each provides an accurate airplane geographical position to the FMC and other aircraft systems. GPS operation is automatic.

GPS Displays

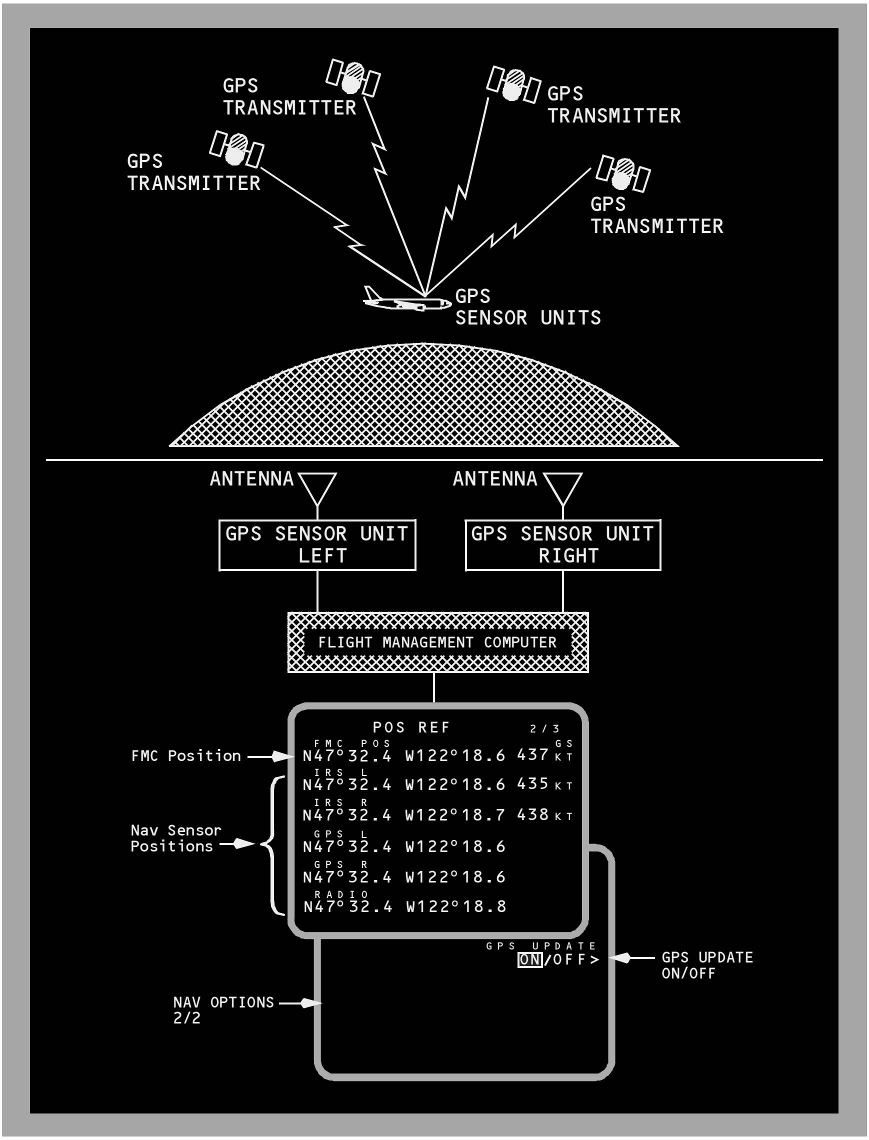
POS REF page 2/3 shows the left and right GPS latitude and longitude position. POS SHIFT page 3/3 shows the left and right GPS position relative to the FMC position. NAV STATUS page 1/2 shows the GPS currently in use by the FMC for position calculation.

GPS Data

The FMC selects a GPS position from one of the available GPS sources as the primary update to the FMC position. When GPS position data is available, radio updating can also occur. If all GPS data becomes unavailable, the FMC position will be determined by radio or inertial (IRS) updating.

GPS navigational information can be manually deselected on the NAV OPTIONS page 2/2. No other controls are provided because the operation of the GPS is completely automatic.

GPS System Schematic



Inertial System

The Air Data Inertial Reference Unit (ADIRU) combines the Air Data Reference System (ADR) and the Inertial Reference System (IRS) into a single Line Replicable Unit (LRU). For information about the air data system, see chapter 10.20.

The IRS partition of the ADIRU computes and provides airplane position, ground speed, heading, and attitude data to the DUs, flight management system, autoflight system, and other systems.

The major components of the inertial system (IRS) are:

- two Air Data Inertial Reference Units (ADIRUs)
- one Inertial System Display Unit (ISDU)
- one IRS Mode Select Unit (MSU)
- one IRS transfer switch.

Inertial Reference System (IRS)

The hybrid GPS-inertial reference function (as installed) is activated when the IRS is connected and has received GPS data and time mark inputs from at least one of the two Multi-Mode Receivers (MMRs). The hybrid GPS-inertial reference function combines IR functions with GPS position information to provide high integrity, high availability data outputs to be used by the flight management system and other airplane systems. When GPS data is not available, the IRS is able to work independently to provide navigation data to other airplane systems like the ADIRU without hybrid GPS-inertial.

Two independent IRSs are installed. Each IRS uses three sets of laser ring gyros and accelerometers to sense the airplane's attitude, rate changes, and accelerations. The IRSs are the airplane's sole source of attitude and heading information, except for the Integrated Standby Flight Display (ISFD) and standby magnetic compass.

In normal navigation mode, the IRSs provide attitude, true and magnetic heading, acceleration, vertical speed, ground speed, track, present position, and wind data to airplane systems. IRS outputs are independent of external navigation aids.

IRS Alignment for the ADIRU with Hybrid GPS-Inertial

An IRS must be aligned before it can enter the navigation mode. When hybrid GPS-inertial is enabled, the ADIRU uses GPS position from the MMRs as present position to initialize the IRS by default and can complete the alignment without flight crew's manual inputs of present position. If GPS position is not available from any MMR, the present position can be entered through the FMC CDU. If the present position cannot be entered through the FMC CDU, it may be entered through the ISDU keyboard. The airplane must remain stationary during alignment.

Normal alignment between 78 degrees 15 minutes North or South is initiated by rotating the MSU switch from OFF to NAV. The IRS performs a short power-up test, during which the ON DC light illuminates. When the ON DC light extinguishes and the ALIGN light illuminates, the alignment process begins. With hybrid GPS-inertial reference, present position is entered automatically using GPS position. Alignment time varies from five minutes to seventeen minutes depending on airplane latitude.

The automatically entered present position can be seen auto-populated on the ISDU PPOS display screen and at the 1R position of the CDU POS INIT page. The POS INIT page displays prompt boxes in the SET IRS POS line to allow the option of manually entering present position if needed. When the IRS completes its alignment and enters NAV mode, the prompt boxes will clear from the CDU POS INIT page.

When a GPS present position is available, but the flight crew chooses to manually enter a present position or the flight crew mistakenly starts entering a present position through the CDU or ISDU before alignment is complete, the automatically entered present position will be overridden by the manually entered position from the flight crew. The flight crew then has the option to complete the IRS alignment using the manually entered present position IRS alignment procedure or re-initiating the automatically entered present position alignment. Re-initiating the automatically entered present position alignment is accomplished by rotating the MSU switch from NAV to OFF, wait 30 seconds, and rotating the MSU switch from OFF to NAV to re-initiate the full alignment. No additional flight crew's inputs are required.

During transit or through-flight stops with brief ground times, a thirty second fast realignment and zeroing of ground speed error may be performed by selecting ALIGN while the airplane is parked. To exit fast alignment and return to Nav mode, present position input is required. In an ADIRU with hybrid GPS-inertial enabled, GPS position can be used as an automatic source of position entry but pilot position entries are optional and have priority over the GPS position source.

When a fast realignment is initiated or the airplane parks after a flight and remains motionless for at least 7.5 to 15 minutes with the ADIRUs still in the NAV mode and valid GPS data available, the ANR (automatic navigation realignment) mode will perform a complete realignment automatically. The ADIRU's position (latitude/longitude) will reset and inertial states (i.e. attitude, heading and horizontal velocities) will reset to remove the drift errors accumulated on the flight. The outputs will reset in a step like manner. The airplane must be stationary long enough for ANR to complete (7.5 to 15 minutes). If the airplane is not stationary long enough for ANR to complete, the ADIRU will not apply any position corrections using GPS and will start over from the beginning when the airplane is stationary again. If the airplane continues to remain motionless the ANR mode will apply small alignment resets once every minute to keep the system from drifting until it moves again.

To prevent an ANR (automatic navigation realignment) pilots should perform an initial full IRS alignment: (i.e. MSU to OFF, then to NAV).

Note: If the airplane is moved or excessive motion is detected during a full alignment, the alignment is paused. The IRS will automatically resume the full alignment 30 seconds after the motion stops. If motion is detected during a fast realignment, the IRS will discontinue the quick alignment, and 30 seconds after the motion stops, will automatically perform a full alignment.

Manual Present Position Entry for IRS Alignment of ADIRU with Hybrid GPS-Inertial

If a GPS position from an MMR is not available during alignment, a manually entered present position alignment process can be used.

Normal alignment between 78 degrees 15 minutes North or South is initiated by rotating the MSU switch from OFF to NAV. The IRS performs a short power test, during which the ON DC light illuminates. When the ON DC light extinguishes and the ALIGN light illuminates, the alignment process begins. Airplane present position should be entered at this time. The present position is normally entered through the FMC CDU POS INIT page. If the present position cannot be entered through the FMC CDU, it may be entered through the ISDU keyboard. Alignment time varies from five minutes to seventeen minutes depending on airplane latitude. The airplane must remain stationary during alignment.

If an entered latitude/longitude position is not within 4 NM of the origin airport, the CDU scratchpad message VERIFY POSITION is displayed. If the entered latitude/longitude position does not pass the IRS internal comparison tests, the scratchpad message ENTER IRS POSITION is displayed.

The flashing ALIGN light alerts the crew that an entered position does not pass one of the two internal comparison tests and should be checked for accuracy. If the entered position does not agree with the last stored position, the first internal test is failed, and the ALIGN light will flash. If the same position is reentered, the IRS will accept the position and continue the alignment process. A second internal position test compares the entered latitude with the system-computed latitude. If this test is failed, the ALIGN light will again flash. If two consecutive entries of the same position do not pass the second internal position test, the FAULT light will illuminate. If the test is passed, the IRS will proceed to complete the alignment process and enter NAV mode. When the alignment is complete, the IRS changes to the navigate mode and the airplane can be moved.

Note: When present position is entered through the CDU prompt boxes, the prompt boxes change to dashes which allows additional entries of present position if needed. When the IRS enters NAV mode, the dashes are cleared from the CDU POS INIT page. When present position is entered through the ISDU, the CDU prompt boxes remain on the POS INIT page. When the IRS enters NAV mode, the prompt boxes are cleared.

During transit or through–flight stops with brief ground times, a thirty second fast realignment and zeroing of ground speed error may be performed by selecting ALIGN while the airplane is parked. Present position should be simultaneously updated by manually entering latitude and longitude prior to selecting NAV.

When a fast realignment is initiated or the airplane parks after a flight and remains motionless with the ADIRUs still in NAV mode, the ADIRUs will enter the ANR (automatic navigation realignment) mode, which is an ALIGN mode that runs while in NAV mode. After at least 5 minutes of no motion, the ANR mode will realign the ADIRU by resetting the inertial states (i.e. attitude, heading and horizontal velocities) to remove the drift errors accumulated on the flight. During ANR mode the ADIRU will accept a manual position entry (i.e. during a fast realignment) to correct the position drift error, this will result in the equivalent of a complete re-alignment. If no position is entered the ANR mode will realign the ADIRU by resetting all the inertial states except position and will continue in NAV mode from its last present position. If the airplane continues to remain motionless the ANR mode will apply small alignment resets once every minute to keep the system from drifting until it moves again.

To prevent an ANR (automatic navigation realignment) pilots should perform an initial full IRS alignment: (i.e. MSU to OFF, then to NAV).

Note: If the airplane is moved or excessive motion is detected during alignment or fast realignment, the IRS automatically begins the full alignment process 30 seconds after the motion stopped.

IRS Alignment for the ADIRU

After the MSU is rotated from OFF to NAV, the IRS performs a short power test, during which the ON DC light illuminates. When the ON DC light extinguishes and the ALIGN light illuminates, the alignment process begins. An IRS must be initialized with accurate airplane present position before it can enter the navigation mode. The present position is normally entered through the left or right FMC CDU. The present position can be entered through the ISDU keyboard. The airplane must remain stationary during alignment. If alignment is interrupted due to motion, the alignment process will stop, and the ADIRU sends "Excessive Motion" message to the FMC/CDU and a status code 03 to the ISDU. Thirty (30) seconds after ADIRU detects no motion, the IRS will automatically restart the alignment process and reset the align time clock from the beginning.

Alignment time varies from 5 minutes to 17 minutes depending on airplane latitude. For latitude between the equator and 60 degrees North or South, the alignment time will vary between 5 minutes to 10 minutes as a function of the latitude. Between 60 degrees and 70.2 degrees North and between 60 degrees and 70.2 degrees South, the alignment time is set at 10 minutes. For latitudes greater than the 70.2 degrees limit (up to the maximum of 78.25 degrees North or South), the alignment time is approximately 17 minutes.

If the entered latitude/longitude position is not within 4 NM of the origin airport, the CDU scratchpad message VERIFY POSITION is displayed. If the entered latitude/longitude position does not pass the IRS internal comparison tests the scratchpad message ENTER IRS POSITION is displayed.

The flashing ALIGN light alerts the crew that the position entered does not pass one of the two internal comparison tests and should be checked for accuracy. If the entered position does not agree with the last stored position, the first internal test is failed, and the ALIGN light will flash. If the same position is reentered, the IRS will accept the position and continue the alignment process. A second internal position test compares the entered latitude with the system-computed latitude. If this test is failed, the ALIGN light will again flash. If two consecutive entries of the same position do not pass the second internal position test, the FAULT light will illuminate. If the test is passed, the IRS will proceed to complete the alignment process and enter NAV mode.

Note: If IRS FAULT light illuminates during alignment, it is recommended that present position is verified for accuracy against GPS position or known local position, and alignment process is repeated.

Fast Realignment - During transit or through-flight stops with brief ground times, a thirty (30) second fast realignment and zeroing of ground speed error may be performed while the airplane is parked by rotating the MSU switches from NAV to ALIGN and back to NAV without rotating the switch to the OFF position. Present position should be simultaneously updated by manually entering latitude and longitude.

Automatic Navigation Realignment (ANR) - ANR is another alignment function that is performed while the IRS is in NAV mode. The purpose of the ANR function is to automatically perform realignment corrections and navigation reset to fine tune the navigation solution (i.e. trim velocities to zero, correct attitude and heading errors, etc.) while the IR is in NAV mode and the aircraft is motionless on ground. These resets allow navigation accuracy to be maintained over long periods of time without performing a normal full alignment. A long segment of no detected motion (7.5 to 15 minutes) is required before the first reset is performed. Resets are then performed at 1-minute intervals until aircraft motion is detected. A subsequent stop for another long segment will again allow resets to occur. Multiple automatic realignments can occur prior to a flight or following a flight.

Loss of Alignment for ADIRU with Hybrid GPS-Inertial

The hybrid GPS-inertial reference has the additional capability to completely recover from an in-flight loss of alignment due to a power interruption or inadvertent shutdown. It's called Align In Motion (AIM). When power is restored to the IRS while in flight, maintain straight and level flight for approximately 30 seconds or until the align light extinguishes; attitude information should become available within a few seconds and full navigation capability is restored automatically within about 10 to 30 minutes. This capability relies on GPS data and is therefore not available if the GPS receivers are not functioning.

Note: During Align In Motion mode, the align times are longest during a continuous straight flight trajectory (up to 30 minutes) and shortest if there are significant changes in airplane heading. With extreme heading changes, such as a complete course reversal, it is possible to complete alignment in less than 5 minutes.

Loss of Alignment for ADIRU

If an IRS loses both AC and DC power, the alignment is lost. Alignment can also be lost if the MSU switch is moved out of the NAV position.

If alignment is lost in-flight, the navigation mode (including attitude, present position and ground speed outputs) is inoperative for the remainder of the flight. However, rotating the MSU switch from NAV to ATT allows the IRS to erect attitude mode. The primary function of the Attitude Mode is to rapidly establish basic pitch and roll attitudes, body rotational rate, and linear accelerations. The attitude mode requires approximately thirty seconds of straight, level, and unaccelerated flight to allow the platform to align itself to the airplane vertical axis for subsequent pitch and roll sensor outputs. The ALIGN light on the MSU is turned on during the 30 seconds attitude mode erection, and extinguish when the IRS enters attitude mode. Some attitude errors may occur during acceleration, but will be slowly removed after acceleration stops.

The FMC/CDU scratchpad message ENTER HEADING is displayed when IRS enters attitude mode. The attitude mode can provide heading information, but to establish compass synchronization the crew must manually enter the initial magnetic heading via the FMC/CDU or ISDU. Drift of up to 15 degrees per hour can occur in the IRS heading. Therefore, when in attitude mode, an operating compass system must be periodically cross-checked and an updated magnetic heading entered in the IRS, as required.

IRS Entries

During IRS alignment, manual IRS entries of present position is normally accomplished on the POS INIT page of the FMC/CDU. The ISDU may also be used for entry of present position.

In attitude mode, manual IRS entries of magnetic heading are required periodically to correct sensor drift overtime. The magnetic heading entries are accomplished on the FMC/CDU or the ISDU.

IRS Power

The IRS can operate on either AC or DC power. The left IRS is normally powered from the AC standby bus, and the right IRS from the AC transfer bus 2. If AC power is not normal or removed, either or both systems automatically switch to backup DC power from the switched hot battery bus and the ON DC light illuminates. Backup DC power to the right IRS is automatically terminated if AC power is not restored within 5 minutes. If either IRS is on backup DC power on the ground, the ground-call horn in the nose wheel sounds to alert maintenance personnel that the IRS is on battery power.

IRS initialization on the ground requires AC or DC input power and the IRS mode selector to move from OFF to ALIGN, or NAV. To avoid loss of IRS alignment during engine start or electrical power bus transfers, AC and DC input power circuit breakers should all be closed. If the IRS losses input power, or if the mode selector is turned to OFF, a full 5-17 minute alignment must be completed again. If the IRS mode select is turned OFF in flight, full NAV mode cannot be restored again until the airplane is on the ground.

When the IRS mode selector is turned OFF, the IRS remains operational for approximately 30 seconds to perform a power down sequence and store position data. The ALIGN light illuminates until the system is completely shut down indicating it is acceptable to remove ADIRU AC and DC input power.

Inertial System Display Unit (ISDU)

The ISDU is located on the aft overhead panel and displays data according to the position of the display selector and system selector. The ISDU also contains a keyboard for entry of present position and magnetic heading (ATT mode).

Note: The ISDU displays true heading (not magnetic).

Mode Select Unit (MSU)

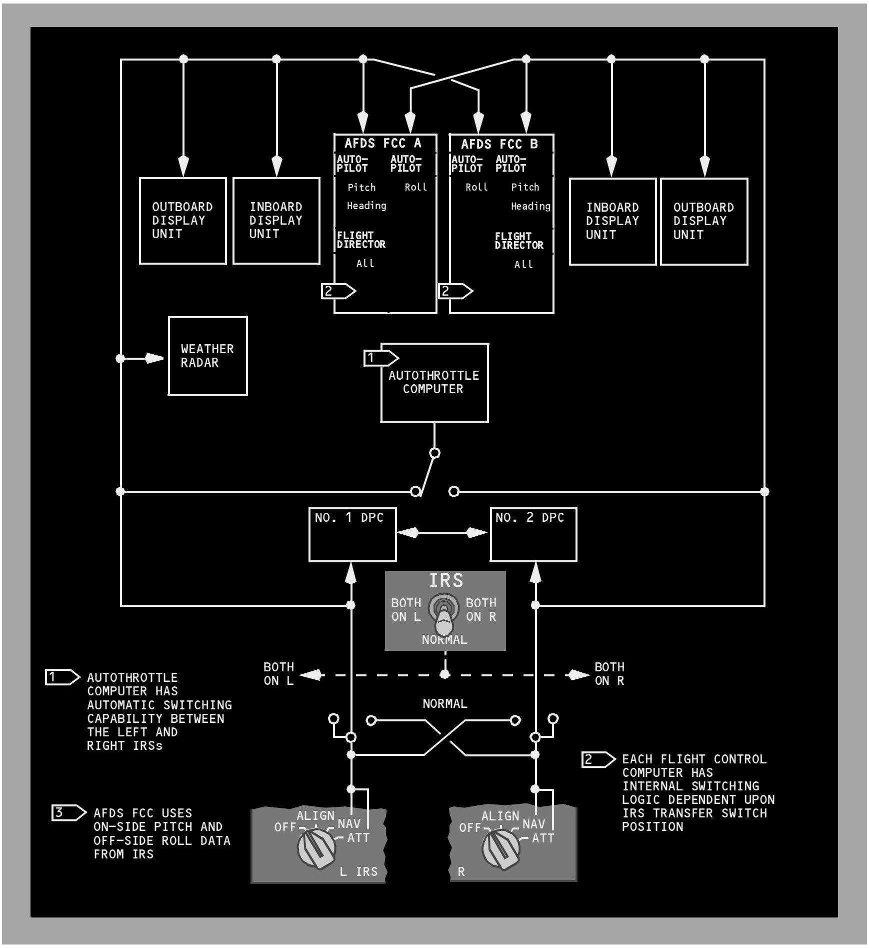
The MSU is located on the aft overhead panel and is used to select the operating mode for each IRS. Indicator lights on the MSU show status of each IRS.

IRS Transfer Switch

Should either IRS fail, the IRS transfer switch is used to switch the connected systems (Flight Control [autopilot and Autothrottle], Displays, Weather Radar, and Digital Flight Data Acquisition Unit) to the functioning IRS.

All other airplane systems, not mentioned above, cannot be switched and are not affected by the IRS transfer switch.

IRS Instrument Transfer Switch Schematic



Radio Navigation Systems

Automatic Direction Finding (ADF)

An automatic direction finding (ADF) system enables automatic determination of magnetic and relative bearings to selected facilities.

One ADF receiver is installed. The ADF bearing signal is sent to the pointer on the DUs. The audio is heard by using the ADF receiver control on the audio selector panel.

If heading or track information is lost or invalid, ADF bearing pointers on the DUs will be removed. Relative bearings, indicated by pointers, may be correct if the receiver is operating.

Distance Measuring Equipment (DME)

Two frequency scanning DME systems are installed.

The FMC autotunes DME receivers as necessary for position updating. During normal operations, two different DME signals or a signal from a collocated VOR/DME pair provide an accurate radio geographical position to the FMC. The identifiers of DMEs currently providing update data to the FMC are displayed on the NAV STATUS page 1/2. The radio position is displayed on the POS REF page 2/3. Specific DME station tuning for FMC position updating can be inhibited on the NAV OPTIONS page 2/2.

The flight crew must manually tune the DME on the VHF navigation control panel and the respective EFIS control panel VOR/ADF switch must be in the VOR position for DME to be displayed on the MDS. DME distance is also displayed on the MDS when the ILS receivers are tuned to a collocated DME and localizer facility.

Multi-Mode Receiver (MMR)

Two Multi-Mode Receivers (MMRs) are installed. Each MMR includes an ILS, GLS (OSS option), VOR, MB and GPS.

Instrument Landing System (ILS)

Two ILS receivers are installed.

The ILS receivers are tuned manually on the VHF navigation control panel. The flight crew must manually tune the ILS for display on the MDS. The ILS localizer and glideslope can also be displayed on the standby attitude indicator.

LOC updating of the FMC occurs only after the ILS is manually tuned.The tuned ILS frequency is displayed on the navigation display in the APP modes.

Navaid Identifier Decoding

The Morse code identifier of a tuned VOR, ILS, or ADF can be converted to alpha characters. The decoded identifier is then shown on the PFD and ND. The crew should monitor this identifier for correct navigation radio reception. The identifier name is not compared with the FMC database.

Due to the large variation in ground station identifier quality, the decode feature may incorrectly convert the intended identifier name. Examples: the Hong Kong localizer “KL” may show as “KAI,” or the Boeing Field ILS may show as “QBFI” or “TTTT” instead of “IBFI.”

Pilots should verify the identity of the tuned navigation station from the audio Morse code when the tuned frequency remains shown or an incorrect identifier is shown.

Marker Beacon

Marker beacon indications for outer, middle and inner marker are displayed on the upper right hand corner of the attitude display located on the Captain's and First Officer's Primary Flight Display (PFD) units.

Very High Frequency Omni Range (VOR)

Two VOR receivers are installed.

The flight crew must manually tune the VOR on the navigation control panel for display on the DUs. VOR–DME radio updating is available if the crew manually tunes a valid in–range VOR station.

Left and right VOR bearings are displayed on the DUs when a valid in–range VOR station is tuned and the respective EFIS control panel VOR/ADF switch is in the VOR position. The DUs also show course deviation.

VHF NAV Transfer Switch

Should either VOR receiver fail, the VHF NAV transfer switch enables selection of the opposite VHF NAV receiver for display.

ATC Transponder

Two ATC transponders are installed and controlled by a single control panel. The ATC transponder system transmits a coded radio signal when interrogated by ATC ground radar. Altitude reporting capability is provided.

Transmissions are automatically enabled when the air/ground system indicates air mode.

TCAS is also controlled from the transponder panel. The TCAS system is described in Chapter 15.

Transponders may also transmit information, such as flight number, airspeed or groundspeed, magnetic heading, altitude, GPS position, etc., depending on the level of enhancement. At some airports, airport equipment monitors airplane position on the ground when the transponder is active (mode selector not in STANDBY or OFF). TCAS modes should not be used on the ground for ground tracking. Automatic Dependent Surveillance-Broadcast (ADS-B) data is downlinked to ATC and can be used for airplane tracking. The left GPS provides data to Transponder 1 containing ADS-B position information and the right GPS provides ADS-B position data to Transponder 2.

Weather Radar

The weather radar system detects and locates various types of precipitation bearing clouds along the flight path of the airplane and gives the pilot a visual indication in color of the clouds' intensity. The radar antenna sweeps a forward arc of 180 degrees.

The radar indicates a cloud's rainfall intensity by displaying colors contrasted against a black background. Areas of heaviest rainfall appear in red, the next level of rainfall in amber, and the least rainfall in green.

In map mode, the radar displays surfaces in red, amber, and green (most reflective to least reflective).

These displays enable identification of coastlines, hilly or mountainous regions, cities, or large structures. Ground mapping mode can be useful in areas where ground–based navigation aids are limited.

The radar system performs only the functions of weather detection and ground mapping. It should not be used or relied upon for proximity warning or anticollision protection.

The turbulence mode displays normal precipitation and precipitation associated with turbulence. When the radar detects a horizontal flow of precipitation with velocities of 5 or more meters per second toward or away from the radar antenna, that target display becomes magenta. This magenta area is associated with heavy turbulence. The detection of turbulence is automatically limited to a 40 nautical mile range, regardless of the selected range.

RDR-4000 IntuVue Radar

The IntuVue weather radar collects data from different scans and merges the information into a total weather picture. Special software eliminates ground clutter resulting in clutter-free viewing of significant weather out to 320 nm. When operating in the automatic mode, multiple radar scans at pre-selected tilt angles detect short, mid, and long range weather. Tilt and gain inputs are not required. This results in weather detection at all ranges and in all phases of flight. Additional processing ensures data from thunderstorm tops within 5,000 feet of the airplane remain on the radar display until it no longer poses a danger, thus, enabling flight around thunderstorms that may not be visible otherwise.

- MAP – The purpose of the MAP mode is to aid in identifying prominent terrain features such as coastlines, lakes, an large built-up urban areas. MAP mode provides an extended ground map picture by piecing together individual scans and combining them in the memory for display. Reflectivity data that is considered ground clutter (and removed from the weather views) is the basis for the Ground Map. Data from the terrain database is not used, providing a independent verification of position. The Ground Map is generated automatically and simultaneously with weather.
- AUTO - Automatic weather mode provides weather, turbulence, and predictive windshear detection. The system processes the data to fill the 3D memory and extracts the selected data for display. When a predictive windshear (PWS) event is detected, an icon is shown on the display. Returns determined to be ground clutter are not shown. Weather targets are color-coded by the intensity of the return. The flight path weather that fills the 3D memory is the detected weather in front of the aircraft out to 320 nm, and from ground level up to 60,000 feet mean sea level (MSL). The radar designates weather along the flight path as “flight path” weather. All other weather is designated as “secondary” weather, and is displayed with black stripes through it.

The nominal Flight Path Weather envelope is ±4,000 ft with respect to the expected flight path. At cruise altitudes above 29,000 ft MSL, the floor of the envelope is extended down to 25,000 ft MSL when necessary to ensure that relevant convective activity is displayed. On the ground and during departure or approach the ceiling of the envelope is fixed at 10,000 ft MSL. This provides approximately 10 minutes of look-ahead. Secondary weather is displayed for situational awareness and to aid in making changes to your flight plan to avoid "flight path" weather.

- MAN – Manual weather mode provides a means to assess storm cell height and development by providing selectable altitude slices. These slices from the 3D memory are corrected for the curvature of the earth, providing a view at a constant MSL altitude level. Selecting MAN on the mode selection knob enters the manual mode. Upon initial selection, the altitude slice is set to the current aircraft altitude (nearest 1000 feet). The altitude (ALT) knob is used to select the desired altitude slice from 0 to 60,000 feet MSL in 1,000 foot intervals. Turbulence information and secondary weather information is removed in MAN mode to enhance analysis of weather reflectivity.

The IntuVue Radar also includes the following features:

- Predictive Hail and Lighting (Hazard Display) – icons will be displayed on top of the reflectivity to identify areas that have the signature characteristics of hail, lightning, or both. The radar does not directly detect hail or lightning; it analyzes the data in the 3D memory to identify areas that have a high probability of containing these hazards.
- Rain Echo Attenuation Compensation Technique (REACT) – as the transmitted radar signal travels through heavy rain it loses power, or becomes attenuated. If this attenuation is severe enough, weather behind a storm cell may not be detectable, or it may be displayed as being less severe than it actually is. REACT automatically indicates areas where the radar signal has been attenuated. These areas are shown as magenta arcs superimposed over the reflectivity in the areas where the signal attenuation is significant.

Windshear

The Predictive Windshear (PWS) feature detects the presence of windshear ahead of the aircraft, giving 10 to 60 seconds of warning before the encounter. Windshear detection mode operates automatically below 1800 ft. Above Ground Level (AGL), with alerts available at 1200 ft. AGL and below. If a Windshear event is detected, the system automatically provides the crew with Caution and/or Warning annunciations, and a Windshear icon appears on the weather display. This system is meant to supplement other means of detecting and avoiding hazardous Windshear conditions. It will not detect all possible hazardous Windshear conditions such as extremely dry events or events masked by unusual radar clutter. The PWS mode can generate three types of alerts; Advisory, Caution, and Warning. These depend on the location of the Windshear event, not the strength. When a Windshear event is encountered below 1200 ft. AGL, the appropriate alert is issued and the icon automatically appears on the display.

If the display is showing data other than weather (such as ground proximity terrain data) when a Windshear event takes place, the display automatically switches into weather mode for presentation of the Windshear icon. The Windshear Icon will be overlaid on the radar display indicated by the mode selection knob on the control panel.

If a Windshear event is encountered while the system is in TEST, the test pattern will be replaced, and the Windshear icon will be overlaid on an AUTO weather display.

WXR-2100 Multiscan Radar

A MultiScan weather radar emulates an ideal radar beam by taking information from different radar scans and merging the information into a total weather picture. Ground clutter suppression algorithms are then used to eliminate ground clutter. The result is the ability for flight crews to view all significant weather from 0 to 320 NM on a single display that is essentially clutter free. With the multiscan process two scans are taken, each optimized for a particular region in front of the aircraft. In general, the upper beam detects intermediate range weather while the lower beam detects short and long range weather by automatically adjusting the beams tilt and gain settings. The information is then stored in a temporary database. When the captain or first officer selects a range, the computer extracts the appropriate portions of the desired information, merges the data, then eliminates the ground clutter. The result is an optimized weather display for whichever range scale the flight crew selects. During automatic operation, multiscan uses variable gain that is based on atmospheric temperature profiles to compensate for variations in geographic location, time of day, and altitude in order to optimize weather returns in all phases of flight. Gain is thus adjusted to suit the environment in which the aircraft is flying and provide the optimum weather picture in the prevailing conditions.

The Multiscan Radar includes the following features:

Path Attenuation Compensation (PAC) Alert places a yellow arc on the outer most range scale to warn the pilot if intervening rain fall has created an attenuated area. PAC Alert is operative whenever the radar is being operated in CAL gain and the aircraft is within 80 NM of a thunderstorm. PAC Alert is activated during both automatic and manual radar operation.

Oceanic Weather Reflectivity Compensation uses aircraft navigation inputs to identify oceanic regions and adjusts gain and tilt to account for the decreased reflectivity of oceanic thunderstorms. Thunderstorm thresholds are adjusted to more accurately represent the true thunderstorm threat to the aircraft.

OverFlight protection is designed to prevent thunderstorms that are in the aircraft flight path from falling below the radar beam and off the radar display during high altitude cruise. At extended ranges the upper MultiScan radar beam scans the wet, reflective portion of a thunderstorm in the same manner that conventional radar scans weather. As the aircraft approaches the storm and the cell begins to fall below the upper radar beam, MultiScan utilizes 6000 ft of bottom beam information to keep the reflective part of the storm in view. Within approximately 15 NM of the aircraft, MultiScan compares the stored digital image of the thunderstorm with the latest sweep information and shows whichever return is greater. If a cell that is a threat to the aircraft begins to fall below the radar beam, MultiScan shows the stored digital image of the storm to make sure that any threat thunderstorm remains on the display until it moves behind the aircraft. OverFlight protection is operational above 22000 ft MSL

Predictive OverFlight tracks cells below the aircraft and measures their growth

rate and intensity when in AUTO and WX+T mode is selected. The system predicts turbulence above the cell and the increasing storm threat along the aircraft flight path. Predictive OverFlight is based on actual radar returns and the resultant analysis of cell growth, not on inference. Predictive Overflight shows as a red enclosure filled with red dots. Predictive OverFlight functions in AUTO mode only with WX+T selected.

Associated Threats are shown while the system is in AUTO and WX+T mode is selected. Associated threats show as red dots on the display and can be within the cell boundary or outside. They are determined by temperature as well as horizontal and vertical radar data. Two type of indications can be shown. The first is the electrified region found in precipitation around the freezing level. This indication shows when the freezing point is within 6000 feet of the aircraft. Associated hazards include icing and lightning. The second type of indication shows as red dots in a rectangle shape over the thunderstorm cell, and may extend beyond the cell in the downwind direction any time the wind is greater than 10 knots above 25 000 feet. The anvil pattern above a storm cell is inferred from the detected cell intensity, and indicates a potential of icing, hail and/or lightning. This shows no matter which altitude the aircraft is at. The electrified region is active for aircraft temperatures warmer than negative

20 degrees C.

Core Threat Adjustment provides a color and size adjustment to closer represent the actual threat. The core threat assessment uses horizontal and vertical growth rates and increases the color and size on the display if a return is below a certain decibel threshold. Core Threat Adjustment functions in AUTO mode only with WX+T selected.

Two-Level Turbulence Detection provides two levels of turbulence detection when in AUTO and WX+T mode is selected. Severe turbulence is shown by solid magenta areas, while light and moderate turbulence (known as ride quality turbulence) is shown by magenta dots. Severe turbulence is indicated when the aircraft g-load is 0.3 g or greater, while ride quality turbulence is indicated when aircraft g-load is 0.2 g. When not in AUTO, the single level of turbulence (0.3g) is available. Two-Level Turbulence Detection functions in AUTO mode only with WX+T selected.

Flight Path/Descent Assessment shows weather for the descent profile as

soon as the aircraft starts a descent. All Multiscan Radar functions are available on the descent. The user does not need to switch to Manual mode to observe weather along the descent.

Windshear

On takeoff Warnings and Cautions are enabled from the beginning of the takeoff roll (0 knots) until the aircraft reaches 80 knots. From 80 knots until the aircraft passes 400 ft, only Warnings are enabled. From 400 ft through 1200 ft, Warnings and Cautions are enabled. All new alerts are disabled from the time the aircraft passes 100 knots until it reaches 50 ft.

On descent, below 2300 ft the weather scan switches from a 180 degree scan to a 120 degree scan, which indicates the windshear detection system is activated. The smaller scan sector allows faster updates and also allows weather and windshear events to be shown simultaneously during the entire windshear event. Windshear detection is always activated when the aircraft is below 2300 ft in the takeoff and landing environment even when the radar is turned off. Warnings and Cautions are enabled from the time the aircraft passes 1200 ft until 400 ft. From 400 ft until 50 ft, only Warnings are enabled. From 50 ft until touchdown (0 ft), all new alerts are disabled.

Windshear detection is activated during both manual and automatic radar operation.

If the radar is on in the MAP or TEST mode and the system detects a windshear event, the system display automatically changes to the WX+T mode to show the weather and windshear icons. The selected range does not change automatically.

A windshear WARNING is generated whenever a detected windshear event occurs within ± 0.25 NM of the longitudinal axis of the aircraft and within ± 30 degrees of the aircraft heading. When the aircraft is on the ground (takeoff roll), the windshear WARNING occurs for windshear events within 3 NM.

A windshear CAUTION is generated whenever a detected windshear event occurs outside the windshear warning region and within ± 30 degrees of the aircraft heading and less than 3 NM from the aircraft.

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Introduction

The flight management system (FMS) aids the flight crew in managing automatic navigation, in–flight performance optimization, fuel monitoring, and flight deck displays. Automatic flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV). The displays include a map for airplane orientation and command markers (bugs) on the airspeed and N1 indicators to assist in flying efficient profiles.

The flight crew enters the desired route and flight data into the CDUs. The FMS then uses its navigation database, airplane position and supporting system data to calculate commands for manual or automatic flight path control.

The FMS can automatically tune the navigation radios and determine LNAV courses. The FMS navigation database provides the necessary data to fly routes, SIDs, STARs, holding patterns, and procedure turns. Lateral offsets from the programmed route can be calculated and commanded.

For vertical navigation, computations include items such as fuel burn data, optimum speeds, and recommended altitudes. Cruise altitudes and crossing altitude restrictions are used to compute VNAV commands. When operating in the Required Time of Arrival (RTA) mode, the computations include required speeds, takeoff times, and enroute progress information.

Flight Management Computer (FMC)

The basis of the flight management system is the flight management computer. Since the term FMC is universally understood, it is used here for standardization and simplification.

The FMC uses flight crew–entered flight plan information, airplane systems data, and data from the FMC navigation database to calculate airplane present position, and pitch, roll, and thrust commands required to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route information are sent to DUs. The EFIS control panels are used to select the desired information for the navigation displays. The mode control panel is used to select the autothrottle, autopilot, and flight director operating modes. Refer to the following chapters for operation of these other systems:

- Chapter 4, Automatic Flight
- Chapter 10, Flight Instruments, Displays.

The FMC and CDU are used for enroute and terminal area navigation, RNAV approaches and to supplement primary navigation means when conducting all types of instrument approaches.

The dual FMC installation is certified as a “sole source” navigation system. Airplanes equipped with two FMCs are certified to operate outside radio navaid coverage. The second FMC serves as a backup, providing complete navigational functions if the other FMC fails.

With a dual FMC installation, one FMC is always designated as primary. This is controlled by the position of the FMC Source Select switch. Refer to Chapter 11, FMC Source Select Switch.

The primary FMC:

- allocates navaid tuning and updating functions between FMCs
- insures synchronization between FMCs
- controls CDU displays
- provides input to the autopilot
- provides input to the autothrottle system
- processes ACARS (data link) messages.

Positioning the FMC Source Select Switch to BOTH ON L or BOTH ON R isolates FMC operation to use only the left or right FMC respectively. In the NORMAL position, the left FMC is primary by default. Although the aircrew can enter information into either CDU, the primary FMC is responsible for synchronizing this information with the secondary FMC and updating both CDU displays.

When external position updating is not available, the FMC uses the IRS position as reference. When the IRS is the only position reference, the FMC applies an automatic correction to the IRS position to determine the most probable FMC position. This correction factor is developed by the FMC’s monitoring IRS performance during periods of normal position updating to determine the typical IRS error value. It is important to note that, when external position updating is not available, navigation accuracy may be less than required. Flight crews should closely monitor FMC navigation, especially when approaching the destination. The accuracy of the FMC navigation should be determined during descent phase by using radio navaids and radar information if available.

Note: Inaccurate position updating may cause the airplane to deviate from the desired track.

Control Display Units (CDUs)

Two identical, independent CDUs provide the means for the flight crew to communicate with the FMC. The crew may enter data into the FMC using either CDU, although simultaneous entries should be avoided. The same FMC data and computations are available on both CDUs; however, each pilot has control over what is displayed on an individual CDU.

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Introduction

When first powered, the FMS is in the preflight phase. As a phase is completed, the FMS automatically transitions to the next phase in this order:

- preflight
- takeoff
- climb
- cruise
- descent
- approach
- flight complete.

Preflight

During preflight, flight plan and load sheet information are entered into the CDU. The flight plan defines the route of flight from the origin to the destination and initializes LNAV. Flight plan and load sheet information provide performance information to initialize VNAV.

Required preflight information consists of:

- initial position
- route of flight
- performance data
- takeoff data.

Optional preflight data includes:

- navigation database
- SID
- STAR
- Route 2
- RTA data
- cruise wind
- reduced takeoff and climb thrust limits.

Each required or optional data item is entered on specific preflight pages.

Preflight begins with the IDENT page. If the IDENT page is not displayed, it can be selected from the IDENT prompt on the INIT/REF INDEX page. Visual prompts provide assistance in selecting the appropriate CDU pages. Preflight pages can be manually selected in any order.

After entering and checking the necessary data on each preflight page, the lower right line select key is pushed to select the next page. When ACTIVATE is selected on the RTE page, the execute light illuminates. The EXEC key is then pushed to complete the task of making the route active before continuing with the preflight.

If a standard instrument departure (SID) is to be entered into the route, the departure/arrival (DEP/ARR) page is selected. After selecting the desired SID, the resulting modification must be appropriately linked to the existing route and executed. This can be accomplished on the RTE or RTE LEGS page.

When all required preflight entries are complete, the preflight status prompts on the TAKEOFF REF page are no longer displayed.

Takeoff

The takeoff phase begins with selection of TO/GA and extends to the thrust reduction altitude where climb thrust is normally selected.

Climb

The climb phase begins at the thrust reduction altitude and extends to the top of climb (T/C) point. The T/C point is where the airplane reaches the cruise altitude entered on the PERF INIT page.

Cruise

The cruise phase begins at the T/C point and extends to the top of descent (T/D) point. Cruise can include step climbs and en route descents.

Descent

The descent phase begins at the T/D point or when either a level change or vertical speed descent is initiated. The descent phase extends to the beginning of the approach phase.

Approach

The approach phase begins two miles from the first waypoint of a published approach or approach transition selected from the ARRIVALS page.

Flight Complete

After landing, the flight complete phase clears the active flight plan and load data. Some preflight data fields initialize to default values in preparation for the next flight.

FMC and CDU Terminology

The following paragraphs describe FMC and CDU terminology.

Active – flight plan information currently being used to calculate LNAV or VNAV guidance commands.

Activate – changing an inactive route to an active route for navigation is a two step process:

- push the ACTIVATE prompt
- push the execute (EXEC) key.

Altitude restriction – a crossing restriction at a waypoint.

Delete – remove FMC data and revert to default values, dash or box prompts, or a blank entry using the DELETE key.

Econ – a speed schedule calculated to minimize operating cost. The economy speed is based on the flight crew CDU–entered cost index. A low cost index reflects high fuel costs and results in a lower cruise speed.

Enter – placing an entry into the CDU scratchpad and then line selecting the information to the desired location. New characters can be typed, or existing data can be line selected into the scratchpad.

Erase – removing flight crew–entered information, which has resulted in a modification, by pushing the ERASE prompt.

Execute – making modified information part of the active flight plan by pushing the EXEC key.

Inactive – route, climb, cruise, or descent information not currently being used to calculate LNAV or VNAV commands.

Initialize – entering information required to make the system operational.

Message – information the FMC automatically writes in the scratchpad to inform the flight crew of a system condition.

Modify – active data that is changed but not yet executed. When a modification is made to the active route or performance mode, MOD is displayed in the page title, ERASE appears next to line select key 6 left, and the execute key illuminates.

Prompt – CDU displays that aid the flight crew in accomplishing a task. Prompts can be boxes, dashes, or a careted (< or >) line to remind the flight crew to enter or validate information.

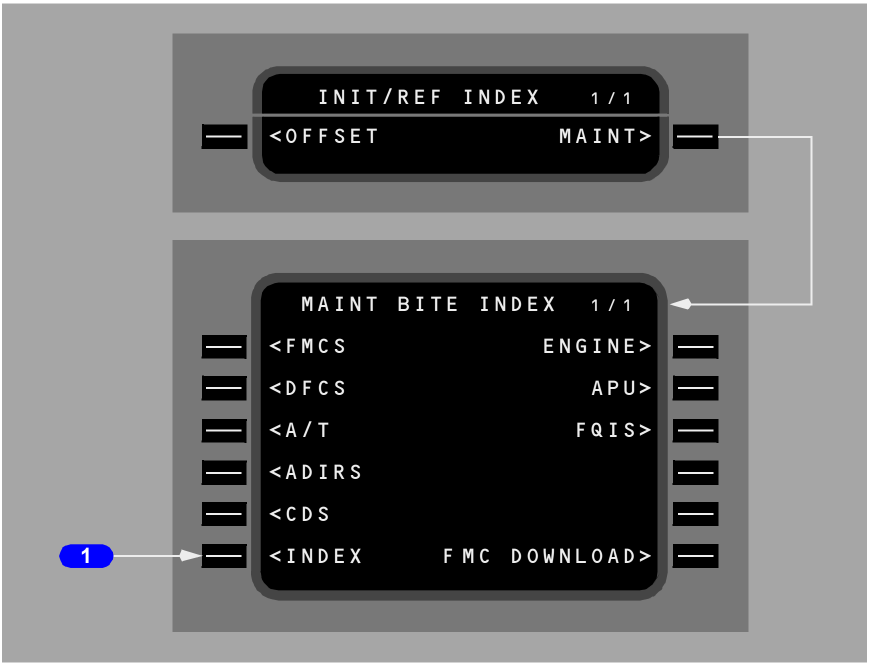
Select – pushing a key to obtain the desired information or action, or to copy selected data to the scratchpad.

Speed restriction – an airspeed limit associated with a specified altitude or waypoint.

Waypoint – a point on the route. It can be a fixed point such as a latitude and longitude, VOR or ADF station, airway intersection, or a non–fixed point such as a conditional waypoint. A conditional waypoint is not necessarily associated with a land reference; it reflects a time position, or altitude requirement. An example of a conditional waypoint is “when reaching 1000 feet.”

Maintenance Index Page

The MAINT BITE INDEX page is available only on the ground and provides access to data for use by maintenance personnel.



1 INDEX

Push – displays the INIT/REF INDEX page.

Navigation Position

The FMC determines present position from the IRS, GPS, and navigation radios. The FMC uses its calculated present position to generate lateral steering commands along the active leg to the active waypoint.

When the FMC Source Select Switch is positioned to NORMAL, the left FMC becomes primary, however, data from both FMCs is combined to determine a composite position and velocity for guidance and map displays.

FMC Position Update

On the ground, the FMC calculates present position based on GPS data. If GPS data is not available, the FMC calculates present position based on IRS data.

If GPS UPDATE is OFF, the FMC updates position to the takeoff runway threshold when a TO/GA switch is pushed. When making an intersection takeoff, the intersection data must be entered on the TAKEOFF REF page. If GPS UPDATE is ON, the TO/GA update is inhibited. GPS UPDATE is on the NAV OPTIONS page.

In flight, the FMC position is continually updated from the GPS, navigation radios, and IRS. Updating priority is based on the availability of valid data from the supporting systems.

FMC position updates from navigation sensor positions are used in the following priority order:

- hybrid GPS (as installed)
- raw GPS
- two or more DME stations
- one VOR with a collocated DME
- one localizer and collocated DME
- one localizer.

- GPS
- two or more DME stations
- one VOR with a collocated DME
- one localizer and collocated DME
- one localizer.

The station identifiers and frequencies of the selected radio navigation aids are displayed on the NAV STATUS page 1/2.

FMC logic selects the hybrid GPS (as installed) inertial position as the primary update to the FMC position. During GPS outages, the hybrid GPS position will remain valid coasting on a calibrated solution with very low drift rates. The GPS L - INVALID and GPS R - INVALID messages will not display in the scratchpad in the case of GPS signal loss. If all GPS data becomes unavailable and the coasting hybrid GPS solution becomes invalid, the FMC reverts to radio or IRS updating.

For normal GPS, FMC logic selects the GPS position as the primary update to the FMC position. If all GPS data becomes unavailable, the FMC reverts to radio or IRS updating.

The dual frequency–scanning DME radios are automatically tuned by the FMC. The stations to be tuned are selected based upon the best available signals (in terms of geometry and strength) for updating the FMC position, unless a specific station is required by the flight plan. Radio position is determined by the intersection of two DME arcs.

If the DME radios fail, or if suitable DME stations are not available and all GPS data is unavailable, FMC navigation is based on IRS position information only. The two VHF Nav radios are used by the FMC for localizer updating during an ILS approach and by the crew for navigation monitoring.

Note: The FMC is designed to automatically reject unreliable navaid data during FMC position updating. However, in certain conditions, navaids which are in error may satisfy the reasonableness criteria and provide the FMC with an inaccurate radio position. One of the most vulnerable times is when a radio position update occurs just after takeoff. This is usually manifested in an abrupt heading correction after engaging LNAV. The position shift can be seen on the map which will shift the desired track and runway symbol to a position significantly different from that displayed during ground roll.

Note: If the flight crew observes either of these indications, the FMC should be carefully monitored.

When adequate radio updating is not available, navigation display map mode may display a shift error. This error results in the displayed position of the airplane, route, waypoints, and navigation aids shifted from their actual positions.

An across track, undetected map shift may result in the airplane flying a ground track that is offset from the desired track. An along track, undetected map shift may result in the flight crew initiating altitude changes earlier or later than desired. In either case, an undetected map shift may compromise terrain or traffic separation.

Map shift errors can be detected by comparing the position of the airplane on the navigation display map mode with data from the ILS, VOR, DME, and ADF systems.

Navigation Performance

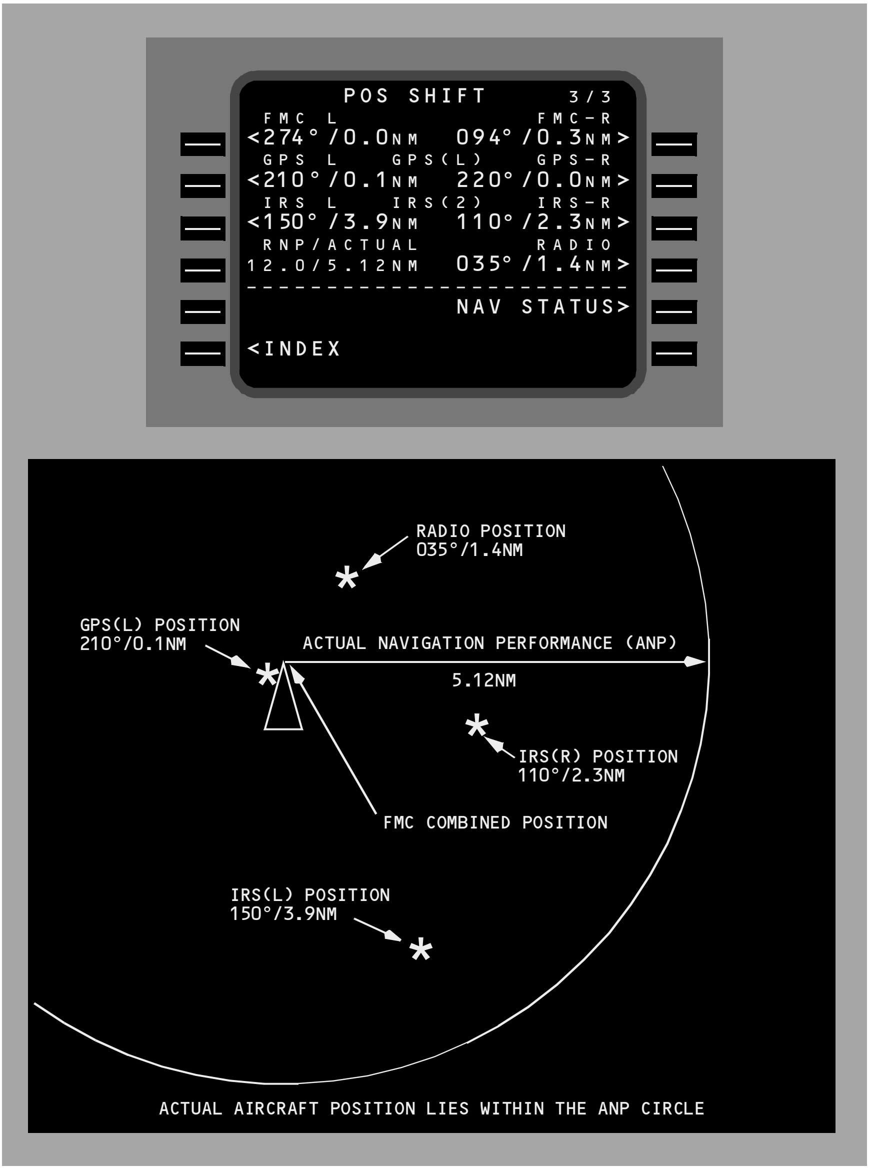
The FMC uses data from the navigation systems to accurately calculate the position of the airplane. The current FMC position is shown on line 1 of the POS REF page 2/3.

The FMC position is derived from a mathematical combination of the positions determined by the IRS, radio, and GPS systems. It represents the FMC’s estimate of the actual position of the airplane. Its accuracy varies according to the accuracy of the other position determining systems.

Note: If the GPS position update is excessive, GPS updating is suspended until the GPS position can be determined to be reasonable.

Actual Navigation Performance (ANP)

Actual navigation performance (ANP) is the FMC's estimate of the quality of its position determination. It is shown on POS SHIFT page 3/3 and on RTE LEGS pages. ANP represents the estimated maximum position error with 95% probability. That is, the FMC is 95% certain that the airplane's actual position lies within a circle with a radius of the ANP value around the FMC position. The lower the ANP value, the more confident the FMC is of its position estimate.


POS SHIFT 3/3
FMC L
FMC-R
<274°/0.0NM
094°/0.3NM>
GPS L
GPS(L)
GPS-R
<210°/0.1NM
220°/0.0NM>
IRS L
IRS(2)
IRS-R
<150°/3.9NM
110°/2.3NM>
RNP/ACTUAL
RADIO
12.0/5.12NM
035°/1.4NM>
NAV STATUS>
<INDEX
RADIO POSITION
035°/1.4NM
GPS(L) POSITION
210°/0.1NM
ACTUAL NAVIGATION PERFORMANCE (ANP)
5.12NM
IRS(R) POSITION
110°/2.3NM
FMC COMBINED POSITION
IRS(L) POSITION
150°/3.9NM
ACTUAL AIRCRAFT POSITION LIES WITHIN THE ANP CIRCLE

Vertical Actual Navigation Performance (VANP)

Vertical Actual Navigation Performance (VANP) is the FMC's estimate of the quality of its altitude determination. It is shown on RNP PROGRESS page 4/5. VANP represents the estimated maximum altitude error with 99.7% probability. That is, the FMC is 99.7% certain that the airplane's actual altitude lies within a vertical band equal to plus or minus the ANP value. The lower the VANP value, the more confident the FMC is of its altitude estimate.

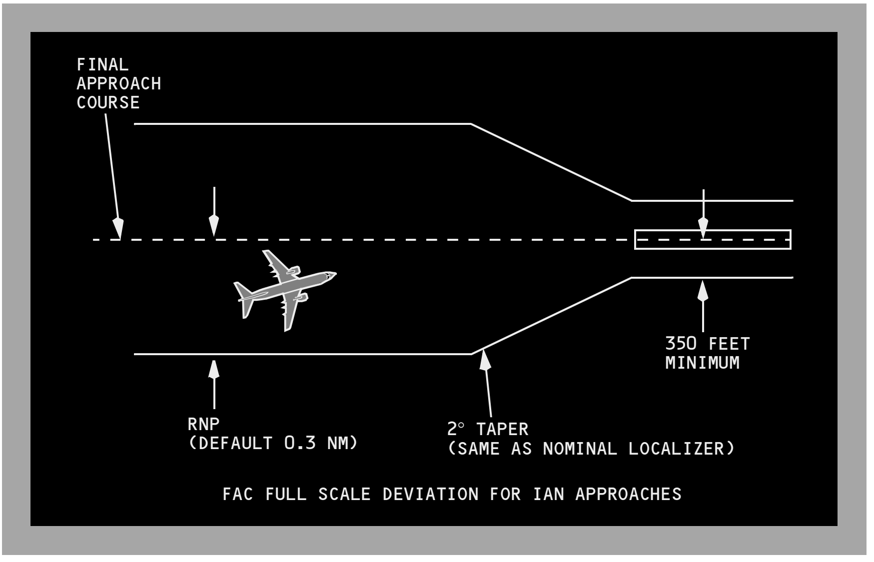
Note: VANP is calculated from the baro-corrected altitude provided by the Air Data System. The pilot must set the baro setting reported by ATIS or provided in the approach clearance for the 99.7% confidence level to be valid.

Required Navigation Performance (RNP)

The FMC supplies a default required navigation performance (RNP) value for oceanic, en route, terminal, and approach environments. RNP can also be supplied by the Navigation Database or may be entered by the crew. Actual navigation performance (ANP) should not exceed RNP.

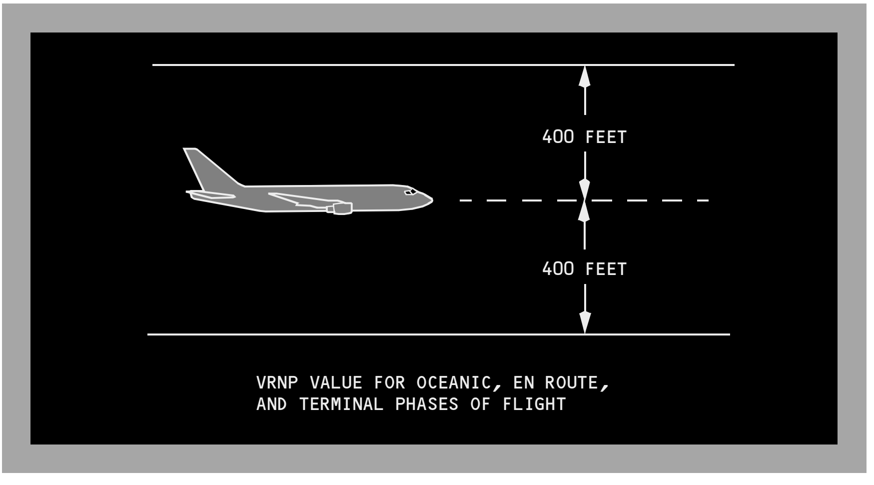
If ANP exceeds the displayed RNP value, the UNABLE REQD NAV PERF–RNP message will be displayed on the CDU scratchpad after the designated time to alert has elapsed. An additional amber UNABLE REQD NAV PERF–RNP will be displayed on the MAP. The amber FMC lights located on the main panel will also illuminate with the annunciation of this message. RNP is shown on the POS SHIFT, RNP PROGRESS 4/5 and the RTE LEGS pages.

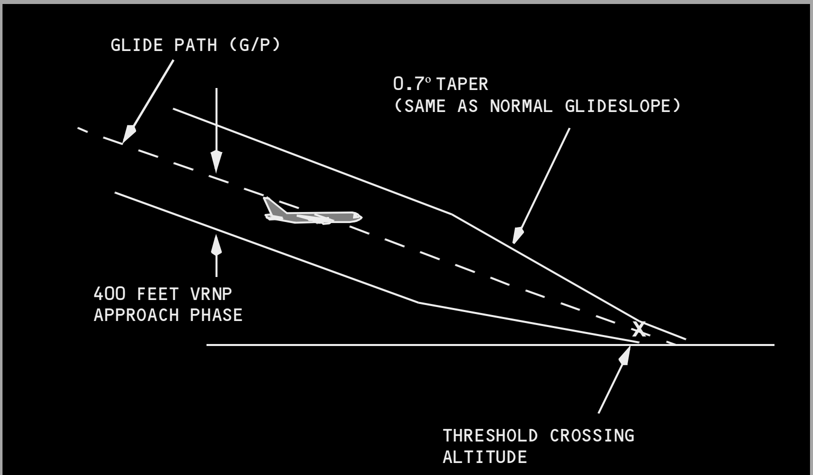
UNABLE REQD NAV PERF-RNP message will be displayed if there are differences between IRU-L and IRU-R inertial sensors (altitude or vertical speed) affecting vertical guidance control or vertical deviation cross track display while the VNAV phase is in DES and the aircraft is on an RNP-AR approach leg.



Vertical Required Navigation Performance (VRNP)

The FMC uses 400 feet as a default Vertical Required Navigation Performance (VRNP) value for oceanic, en route, and terminal phases of flight.





G/P FULL SCALE DEVIATION FOR IAN APPROACHES

When required, VRNP values may be manually entered or displayed on RNP PROGRESS page 4/5. The FMC will accept manual entry of a VRNP value greater than the default value, but the VERIFY VERT RNP VALUE advisory message will be displayed in the scratchpad. Manual entries are cleared at flight completion.

Lateral Navigation (LNAV)

LNAV provides steering commands to the next waypoint. If selected, LNAV engages when laterally within 3 nautical miles of the active route leg. If outside of 3 nautical miles of the active route leg, LNAV engages if on an intercept heading of 90 degrees or less and the intercept will occur before the active waypoint. FMC LNAV guidance normally provides geodetic paths between waypoints. However, when an arrival or approach from the FMC database is entered into the active route, the FMC can supply commands to fly a constant heading, track, or follow an arc, as required by the procedure.

Waypoints

Waypoint (navigation fix) identifiers are displayed on the CDU and navigation display.

The CDU message NOT IN DATA BASE is displayed if a manually entered waypoint identifier is not stored in the database. The waypoint can still be entered as a latitude/longitude, place–bearing/distance or place–bearing/place–bearing waypoint.

FMC–generated waypoints contain a maximum of five characters assigned according to the following rules.

Navaid Waypoint Names

VHF – waypoints located at VHF navaids (VOR/DME/LOC) are identified by the official one, two, three or four character facility identifier. Examples:

- Los Angeles VORTAC – LAX
- Tyndall TACAN – PAM
- Riga, Latvia – RIX.

NDB – waypoints located at NDBs are identified by use of the station identifier. Example:

- Fort Nelson, CAN – YE.

Fix Waypoint Names

Fixes with one–word names – waypoints located at fixes with names containing five or fewer characters are identified by the name. Examples:

- DOT
- ACRA
- ALPHA.

Long Waypoint Names

Names with more than five characters are abbreviated using the following rules sequentially until five characters remain. Double letters are deleted. Examples:

- KIMMEL becomes KIMEL
- COTTON becomes COTON
- RABBITT becomes RABIT.

Keep the first letter, first vowel and last letter. Delete other vowels starting from right to left. Examples:

- ADOLPH becomes ADLPH
- BAILEY becomes BAILY
- BURWELL becomes BURWL.

Keep the last letter, then delete consonants from right to left. Examples:

- ANDREWS becomes ANDRS
- BRIDGEPORT becomes BRIDT
- HORSBA becomes HORSA.

Fixes with multiword names use the first letter of the first word and abbreviate the last word, using the above rules sequentially until a total of five characters remain. Examples:

- CLEAR LAKE becomes CLAKE
- ROUGH ROAD becomes RROAD.

Unnamed Point Waypoint Names

Unnamed turn points, intersections and DME fixes – if an unnamed turn point, intersection or fix is collocated with a named waypoint or navaid on a different route structure (such as low altitude routes or an approach), the name or identifier of the collocated waypoint is used. Example:

- Unnamed turn point on J2 between the Lake Charles (LCH) and New Orleans (MSY) VORTACs is coincidental with the Lafayette (LFT) low altitude VORTAC. LFT is used as the identifier for the turn point.

Identifier codes for unnamed turn points not coincidental with named waypoints are constructed from the identifier of a navaid serving the point and the distance from the navaid to the point. If the distance is 99 nautical miles or less, the navaid identifier is placed first, followed by the distance. If the distance is 100 nautical miles or more, the last two digits are used and placed ahead of the navaid identifier. Examples (NAVAID – DISTANCE – IDENT):

- INW – 18 – INW18
- CSN – 106 – 06CSN
- TCS – 89 – TCS89.

Unnamed flight information region (FIR), upper flight information region (UIR), and controlled airspace reporting points – waypoints located at unnamed FIR, UIR, and controlled airspace reporting points are identified by the three–letter airspace type identification followed by a two–digit sequence number.

Unnamed oceanic control area reporting points – positions in the northern hemisphere use the letters N and E, while positions in the southern hemisphere use the letters S and W. Latitude always precedes longitude. For longitude, only the last two digits of the three digit value are used.

Placement of the designator in the five character set indicates whether the first longitude digit is 0 or 1. The letter is the last character if the longitude is less than 100° and is the third character if the longitude is 100° or greater.

N is used for north latitude, west longitude. E is used for north latitude, east longitude. S is used for south latitude, east longitude. W is used for south latitude, west longitude. Examples:

- N50° W040° becomes 5040N
- N75° W170° becomes 75N70
- N50° E020° becomes 5020E
- N06° E110° becomes 06E10
- S52° W075° becomes 5275W
- S07° W120° becomes 07W20
- S50° E020° becomes 5020S
- S06° E110° becomes 06S10.

Procedure Arc Fix Waypoint Names

Unnamed terminal area fixes along a DME arc procedure – unnamed fixes along a DME arc procedure are identified with the first character D. Characters 2 through 4 indicate the radial on which the fix lies. The last character indicates the arc radius. The radius is expressed by a letter of the alphabet where A = 1 mile, B = 2 miles, C = 3 miles, and so forth. Examples:

- EPH252°/24 = D252X
- EPH145°/24 = D145X
- GEG006°/20 = D006T.

An unnamed waypoint along a DME arc with a radius greater than 26 miles is identified as an unnamed turn point that is not coincidental with a named waypoint. Examples:

- CPR338°/29 = CPR29
- GEG079°/30 = GEG30.

When there are multiple unnamed waypoints along a DME arc with a radius greater than 26 miles, the station identifier is reduced to two characters, followed by the radius, and then a sequence character. Examples:

- CPR134°/29 = CP29A
- CPR190° /29 = CP29B
- CPR201°/29 = CP29C.

Procedure Fix Waypoint Names

Marker beacons – a marker beacon is identified by the marker type identifier followed by the runway number. Examples:

- Outer Marker 13R = OM13R
- Middle Marker 21 = MM21.

Runway–related fixes – waypoints located at unnamed runway–related fixes are identified by adding a two–letter prefix to the runway number. The following list is used to determine the appropriate prefix:

- RX – runway extension fix
- FA – VFR final approach fix
- CF – final approach course fix
- FF – final approach fix
- IF – initial approach fix
- OM – outer marker
- MM – middle marker
- IM – inner marker
- BM – back course marker
- MD – minimum descent altitude
- A – (+ an alpha) step down fix
- RW – runway threshold
- MA – missed approach point other than RW
- TD – touchdown point inboard of RW.

Examples: OM25L, MM09, IM23, RW04, RW18L.

For airports with more than one approach to the same runway, the two letter prefix may change to allow different identifiers for the same waypoint. The first letter identifies the type of fix and the second letter identifies the type approach as follows:

- C( ) – final approach course fix
- F( ) – final approach fix
- P( ) – missed approach point
- I( ) – initial approach fix
- D( ) – minimum descent altitude
- T( ) – touch down point
- R( ) – runway centerline intercept.
- ( )I – ILS
- ( )L – localizer only( )B –backcourse ILS
- ( )D – VOR/DME
- ( )V – VOR only
- ( )S – VOR with DME points
- ( )N – NDB
- ( )Q – NDB with DME points
- ( )M – MLS
- ( )T – Tacan
- ( )R – RNAV.

Examples: CI32R, PV15, FN24L.

Unnamed turn points – unnamed turn points that are part of a procedure are identified as a latitude and longitude waypoint. These include waypoints (except conditional waypoints) defined by flying a course or track from a waypoint (except conditional waypoints) to a radial or DME distance. These waypoints are automatically entered in a route by selection of a procedure using these waypoints, from the departures or arrivals page.

Airport reference points – airport reference points are identified by the ICAO identifier.

Duplicate Waypoint Names

Duplicate identifiers – should application of these rules result in more than one waypoint having the same identifier, then a CDU page change occurs when an attempt is made to enter the duplicated identifier.

The page title is SELECT DESIRED XXX, where XXX is the three letter identifier of the waypoint in question.

The page lists the latitude and longitude of waypoints with the same identifier and the type of facility or waypoint. Selecting the latitude/longitude of the desired waypoint enters the correct waypoint on the original page. See chapter 11, section 42, “Select Desired Waypoint Page” for additional information.

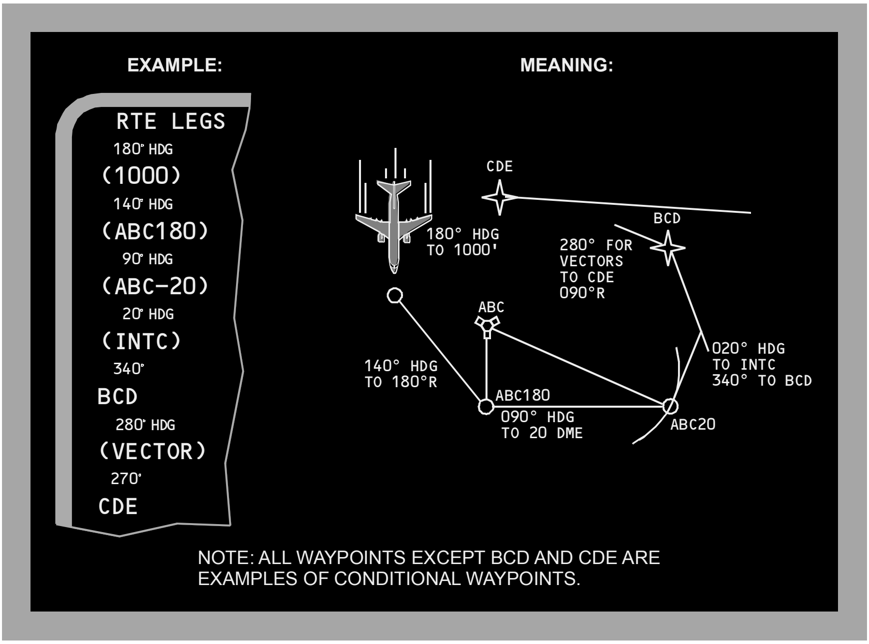
When a waypoint identifier is listed in the route more than once, certain route modifications (such as DIRECT TO or HOLD) use the first occurrence of the waypoint even if the second occurrence is selected. If a new waypoint entry is attempted that has the same identifier as a waypoint already in the route, the select desired waypoint page will not be displayed and the first waypoint will be used. To use the second occurrence waypoint, the first occurrence waypoint must be deleted from the route.

Conditional Waypoint Names

Conditional waypoints are automatically entered into a route as a result of selecting a procedure on a DEPARTURES or ARRIVALS page. Normally, conditional waypoints cannot be manually entered on a route or legs page. These waypoints are events when a condition occurs and are not at a geographically–fixed position. The types of conditions are:

- passing through an altitude
- flying a heading to a radial or DME distance
- intercepting a course
- heading vector to a course or fix.

Altitude and course intercept conditional waypoints are displayed on the CDU inside (parentheses) marks. The following diagram depicts conditional waypoints.



Note: When (VECTOR) is the active leg and LNAV is not engaged, the FMC automatically sequence to the next waypoint when within 3 nm of the next leg. If (VECTOR) is the active waypoint and LNAV is engaged, the FMC does not automatically sequence to the next waypoint. The next waypoint becomes active only upon EXECution of the procedures for Proceeding Direct To a Waypoint or Intercepting a Leg to a Waypoint.

Manually Entered Latitude/ Longitude Waypoint Names

Pilot defined waypoints entered as a latitude and longitude are displayed in a five–character format. The first three characters are WPT followed by a two digit sequence number. Latitude and longitude waypoints are entered with no space or slash between the latitude and longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude are full degrees. Examples:

- N47° W008° is entered as N47W008 and displayed as WPT01
- N47° 15.4’ W008° 3.4’ is entered as N4715.4W00803.4 and displayed as WPT02.

Manually Entered Place–Bearing/Distance or Place–Bearing/Place–Bearing Waypoint Names

Waypoints entered as a place–bearing/distance or place–bearing/place–bearing are identified by the first three characters of the entry followed by a two–digit sequence number. Examples:

- SEA330/10 becomes SEA01
- SEA330/OLM020 becomes SEA02.

Manually Entered Along–Track Waypoint Names

Along–track waypoints are a special case of place–bearing/distance waypoints applied to the current route. When a waypoint is desired on the route where none exists, the along–track waypoint feature creates the desired waypoint without creating a route discontinuity.

Along–track waypoints are entered using the waypoint name (the place), followed by a slash and minus sign, for points before the waypoint, or no sign for points after the waypoint, followed by the mileage offset for the newly defined waypoint. The route course takes the place of the bearing which is not entered. The created waypoint is then inserted over the original waypoint. The distance offset must be less than the distance between the originating waypoint and next (positive value) or preceding (negative value) waypoint. Latitude and longitude waypoints cannot be used to create along–track waypoints. Examples:

- VAMPS/25 is 25 miles after VAMPS on the present route, and is displayed as VAM01
- ELN/–30 is 30 miles before ELN on the present route, and is displayed as ELN01.

Greater Than 99 Numbered Waypoints

When the quantity of numbered waypoints exceeds 99 the identifier shall use the first two characters of the entry followed by the smallest three-digit sequence number beginning with 100. Examples:

- SEA104/74 becomes SE100
- SEA104/OLM064 becomes SE101.

Navigation Displays

The route is displayed on the navigation display in the map, map center, and plan modes. The display color and format represent the following status:

- an inactive route is displayed as a cyan dashed line
- an activated but not yet executed route is displayed as a cyan dashed line
- the active route is displayed in magenta
- modifications to an active route are displayed as dashed white lines
- missed approach route is displayed as cyan dashed line until active

- modified waypoints are displayed in white
- executed route offsets are displayed as a dot and dash magenta line.

Vertical Navigation (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight.

Speed/Altitude Restrictions

VNAV controls the path and speed to comply with waypoint crossing restrictions. Waypoint crossing restrictions are entered on the LEGS page waypoint line by pushing the applicable key on the right side of the CDU. Barometric altitude restrictions must be below the cruise altitude to be valid. Values entered as part of a procedure and manually entered restrictions are shown in large font. FMC predicted values do not act as restrictions, and are shown in small font.

A waypoint restriction is magenta when it is active. The restriction does not have to be in line 1 to be active.

Modified waypoint restrictions are shaded white until they are executed.

All speed restrictions are considered by the FMC as “at” restrictions, unless modified by the pilot.

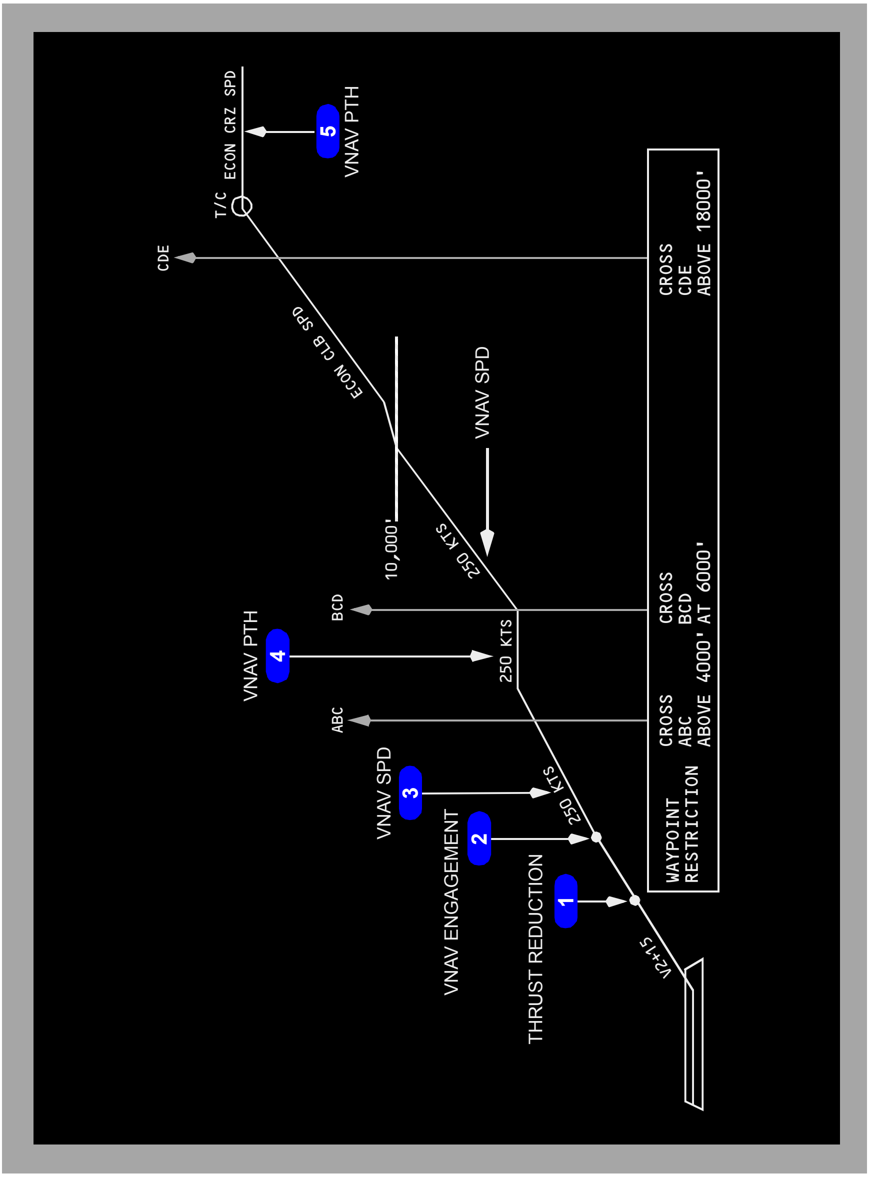
When modified by the pilot:

- “At or above” airspeed restrictions are entered with a suffix letter A (example: 250A/).
- “At or below” airspeed restrictions are entered with a suffix letter B (example: 200B/).
- Mandatory airspeed restrictions are entered without any suffix letter (example: 220/).

At or above altitude restrictions are entered with a suffix letter A (example: 220A). At or below altitude restrictions are entered with a suffix letter B (example: 240B). Mandatory altitude restrictions are entered without any suffix letter (example: 270).

Altitude restrictions that are between two altitudes are displayed with the lower altitude limit first, then the upper altitude limit (example: 14000 FL240).

Takeoff and Climb



1 Thrust Reduction

Climb thrust is selected by pushing the N1 switch or automatically upon reaching the thrust reduction altitude.

2 VNAV Engagement

VNAV commands an airspeed increase to the planned climb speed profile, limited by configuration.

3 VNAV Climb

The VNAV climb profile uses VNAV SPD at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude restrictions that are part of the SID entered into the active route. Autothrottle uses selected climb thrust limit.

Note: Selection of ENG OUT on the CLB page provides the crew with advisory engine out performance information.

If the climb speed profile cannot achieve an altitude restriction, the UNABLE NEXT ALTITUDE scratchpad message is shown.

4 Climb Restrictions

VNAV enters the VNAV PTH mode to remain within departure or waypoint restrictions. Speed maintained during this time can be:

- procedure based speed restriction
- waypoint speed restriction
- default VNAV climb speed
- manually entered climb speed.

5 Top Of Climb (T/C)

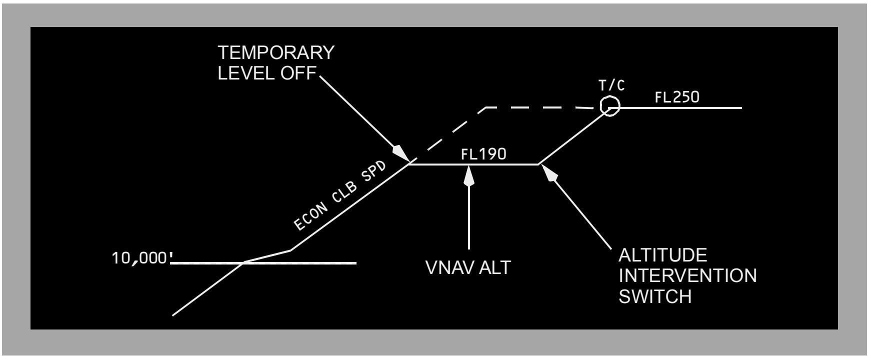
The point where the climb phase meets the cruise altitude is called the top of climb. Approaching this point, the FMC changes from the climb phase to the cruise phase. The T/C is shown any time the FMC calculates a change from a climb phase to a cruise phase, such as a step climb.

The T/C point is shown on the map as a green open circle with the label T/C.

MCP Altitude Intervention

The altitude intervention switch may be used to resume climb after a temporary level off.

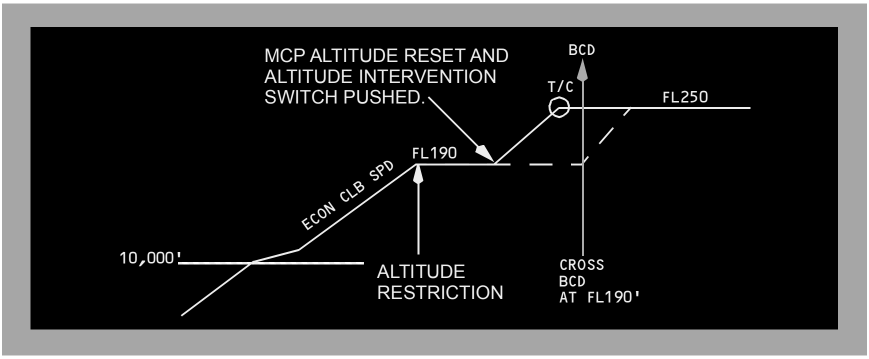
The Altitude Intervention function will only apply to the active flight plan.



Whenever the airplane levels off at an MCP altitude that is not in the FMC, VNAV ALT engages. In the illustration above, FMC cruise altitude is FL250 and the clearance altitude, FL190, is set in the MCP. Pitch maintains altitude and thrust maintains FMC target speed. In the illustration above, the speed after the temporary level off would be ECON CLB SPEED.

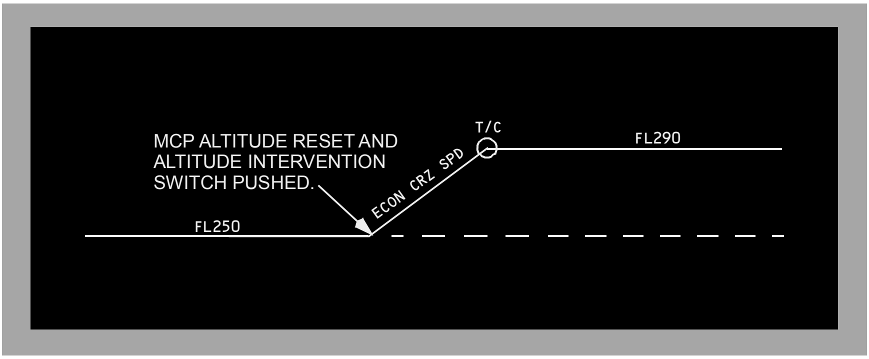
To resume the climb, put the clearance altitude into the MCP altitude window and push the altitude intervention switch. VNAV SPD engages. Pitch maintains FMC speed and thrust increases to the climb limit. In the example, the airplane climbs to FMC CRZ ALT and then levels off in cruise.

The altitude intervention switch may be used during climb or descent to delete altitude restrictions between the current altitude and the MCP altitude. When level at a restriction altitude, and cleared to a higher altitude prior to crossing the restriction waypoint, reset the MCP altitude to the new clearance altitude and push the altitude intervention switch.



In the illustration above, the current altitude restriction is deleted and the airplane continues VNAV climb to the cruise altitude. T/C moves to match the new climb profile.

The altitude intervention switch may be used to increase cruise altitude. When level at a cruise altitude, and then cleared to a higher cruise altitude, reset the MCP altitude to the new cruise altitude and push the altitude intervention switch.



In the illustration above, the cruise altitude is increased and the airplane enters a VNAV cruise climb at the economy cruise speed.

Altitude Intervention will only apply to the active flight plan.

Altitude Intervention will enabled a climb or descent to a new cruise altitude to be initiated from the Mode Control Panel.

Altitude Intervention allows the crew to initiate a cruise descent using the altitude intervention feature on the Mode Control Panel when the airplane is not in close proximity to the top of descent. A distance of 50 NM is used as a determinant for this operation. If the airplane is greater than 50 NM from T/D, the pilot may dial the MCP altitude down and press the ALT INTV button on the MCP. FMC response is similar to use of Altitude Intervention for a cruise climb initiation. FMC ALT is set to the new cruise altitude and cruise descent is initiated using existing guidance techniques for cruise descent. A CRZ DES can be initiated using altitude intervention when greater than 50 NM from top of descent provided that the MCP ALT is not set below a descent altitude constraint. For this condition of more than 50 nm to T/D, and the MCP altitude dialed below a descent constraint, the result of pressing the ALT INTV button will be to transition from CRZ to EARLY DES and to honor the constraint. Subsequent presses of the ALT INTV button may be used to delete the constraint.

Cruise

At cruise altitude, the FMC sets cruise speed at the default or pilot entered speed until reaching the top–of–descent (T/D) point. Alternate cruise speed options are:

- long range (LRC)
- flight crew entered speed.

Cruise thrust is set as required to maintain level flight at the target speed, with the autothrottle engaged. The FMC uses maximum range cruise speed if cost index is set to zero.

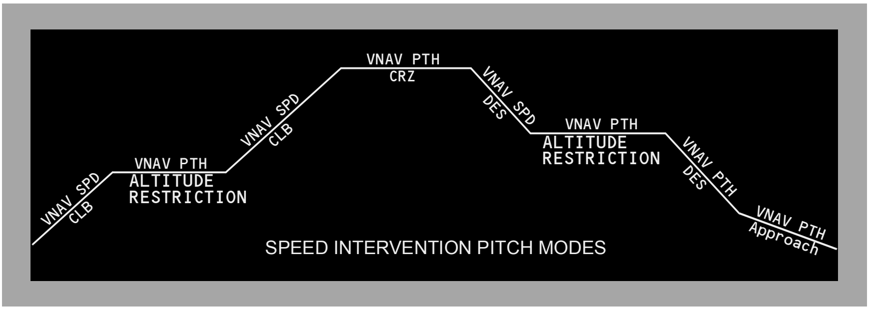
Fuel and ETA predictions are based on a constant altitude cruise unless a step climb altitude is entered.

Step Climb

If a step climb altitude is entered in the CRZ page STEP altitude, the FMC calculates the point where the step climb should begin.

The distance and ETA to the next step point are shown on the CRZ and PROGRESS pages. The next step point is shown on the map as a green open circle with the label S/C.

MCP Speed Intervention



The above illustration shows VNAV mode for each phase of flight during speed intervention.

With VNAV engaged, pushing the speed intervention switch enables speed intervention. Speed intervention allows the flight crew to change airplane speed with the IAS/MACH selector.

In a path descent using speed intervention, VNAV PTH changes to VNAV SPD when the active descent segment is an idle or non-idle thrust segment. In VNAV PTH, thrust controls speed; in VNAV SPD, pitch controls speed.

Note: Aircraft equipped with geometric descent path will transition to VNAV PTH after the first altitude restriction.

FMCS speed targets constrain the aircraft within its operating limits except when in the speed intervention mode. These operating limits include stall protection, maximum operating speed, flap placards, thrust limits, and maneuver margins.

When a navigation data base vertical angle leg is flown (GP x.xx on RTE LEGS page), VNAV switches to VNAV PTH if not already in VNAV PTH.

In approach phase during speed intervention, the pitch mode remains in VNAV PTH after speed intervention is exited. The FMC shall remain in the current vertical mode regardless of IAS MACH selector changes.

Descent

VNAV performs descents using pitch control to maintain a vertical path. Thrust is used to control speed, similar to a glideslope in three dimensions.

Top Of Descent (T/D)

The point where the cruise phase changes to the descent phase is the top of descent. The T/D point is shown on the map as a green open circle with the label T/D. T/D is calculated from an end of descent (E/D) point.

Intermediate T/D points show on the map as green open circles with the label T/D–XXXXX (altitude). Intermediate T/D points exist when path segments between altitude restricted waypoints produce a level path segment. The intermediate T/D point shows where the descent will resume.

When an exit from a holding pattern is requested by the pilot through CDU action:

- a turn path to the inbound leg will be generated immediately if the airplane is on the outbound leg or in the fix end turn when the T/D does not occur in the hold pattern.
- the entire hold pattern shall be flown when the T/D does occur in the hold pattern.

End of Descent (E/D)

The FMC calculates a descent path based on airspeed restrictions, altitude restrictions and the end of descent (E/D) point. The E/D point is shown on the map as a green open circle with the label E/D. The E/D is the last of the following which is not preceded by a lateral discontinuity:

- the runway threshold for approaches with a runway waypoint on the active RTE LEGS page, or
- the missed approach point for approaches not showing a runway waypoint on the active RTE LEGS page, or
- the last descent waypoint, or
- the lowest “at” altitude restriction if no arrival procedure is entered.

Entering an instrument arrival procedure provides an E/D point.

VNAV Descent and Approach Path

The descent path starts at the calculated top of descent (T/D) point and includes waypoint altitude restrictions. The path is based on:

- idle thrust
- speedbrakes retracted
- descent wind speed decreasing with decreasing altitude
- applicable target speed.

After the first "at" or "at or below" restriction, the path angle is constant between waypoints.

Note: When passing top of descent and using high target speeds (within approximately 6 knots of Vmo/Mmo), VNAV may revert to VNAV SPD to prevent overspeed.

Normally, the target speed is economy speed above the airspeed restriction altitude and 240 knots below that altitude, until deceleration for approach. VNAV will not permit descent below the airspeed restriction altitude until the airspeed is at or below the restricted value plus ten knots. The start and end of the airport speed restriction deceleration segment is shown on the map as a green open circles with no labels.

The descent path assumes deceleration to reach the final approach fix (FAF), or the glideslope intercept point at VREF 40+20 knots.

Target speeds are changed by entries on the DESCENT page. Entries made on the LEGS page are "at or below" and may limit the target speed. Wind and thrust assumptions are changed on the DES FORECASTS page.

Deceleration points show on the map as green open circles with the label DECEL. Deceleration points show prior to:

- airspeed constrained waypoints
- holding patterns
- approach flap extension.

If more than one deceleration segment exists in the flight plan, only the next deceleration point shows. Deceleration points can also show prior to cruise holding patterns or other speed reductions.

During descent, VNAV ALT engages if the airplane levels at an MCP altitude not in the FMC.

VNAV Path Descent

An E/D point must be defined in order to accomplish a path descent. It may be defined manually or by the selection of an arrival procedure.

The path descent normally begins automatically at the calculated T/D point, provided the MCP altitude is reset for the descent. If descent is not initiated by the T/D, a path descent may not be achievable. At the T/D, the FMC commands idle thrust and pitch to follow the descent path.

The descent complies with waypoint altitude restrictions by following the calculated vertical path.

Note: A path descent uses the target speed for planning purposes only. There is no attempt to maintain the target speed during the idle portion of the descent.

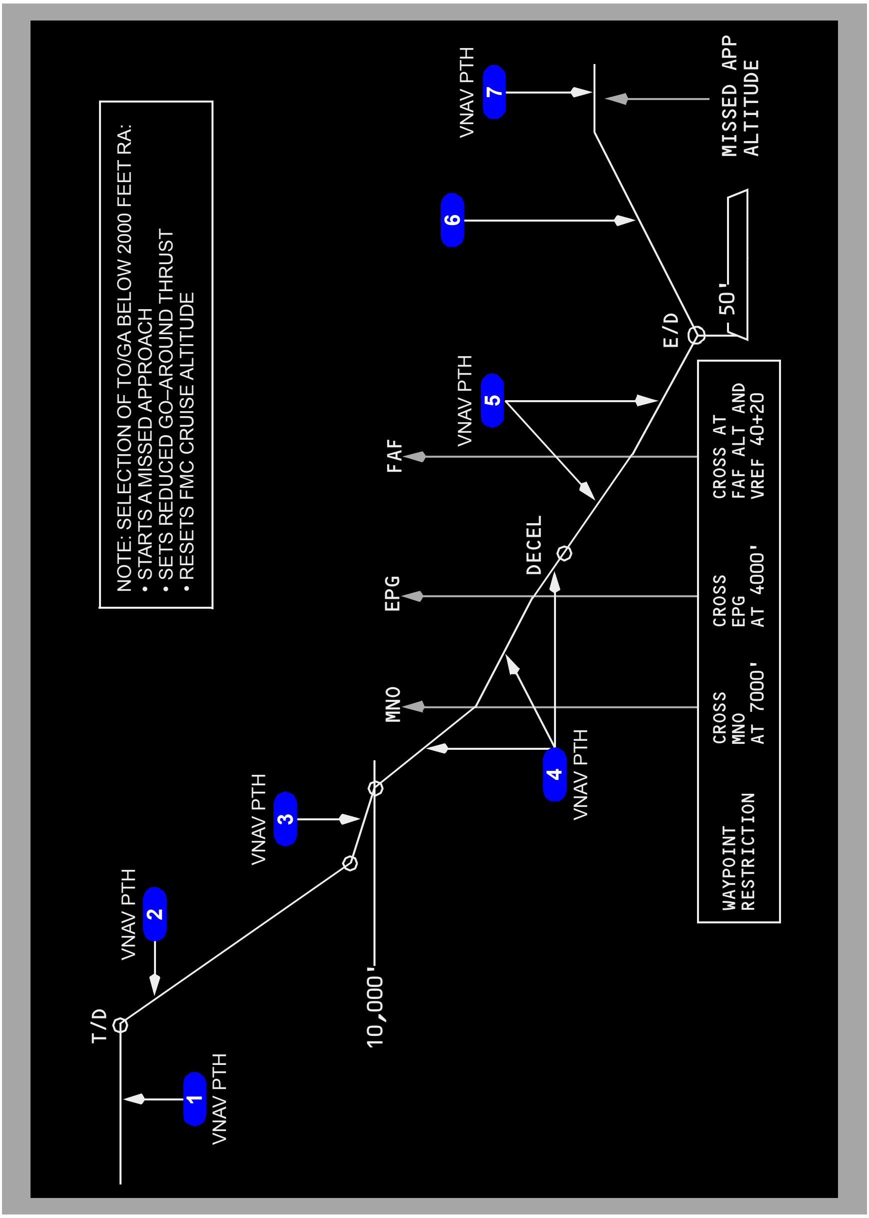
Note: When in path descent, if actual airplane speed is less than the descent target speed by a customized threshold amount loaded in the Loadable Defaults Database, the FMC will transition to FMC SPD as the thrust mode. The valid range for the threshold is 5 to 15 knots. The A/T mode returns to the retard/arm mode when the airplane speed is then equal to the target speed.

Note: When descending in VNAV PTH, the FCC will disengage VNAV and switch to LVL CHG if actual speed becomes equal to or slightly less than the minimum speed, denoted by the underspeed limiting symbol in the MCP IAS/Mach window. This can also happen in turbulence or gusty conditions when the minimum speed may momentarily increase due to G loading. See section 4.20, Minimum Speed Reversion.

The CDU message DRAG REQUIRED is displayed if an unexpected tailwind results in a significant increase in airspeed to maintain path. VNAV reverts to VNAV SPD if a limit speed will be exceeded, with COMMON VNAV.

A path descent must be initiated while within the allowable cross–track error for LNAV, however LNAV may be disengaged during descent while remaining in the path mode. VNAV will remain in path regardless of cross–track.

VNAV Cruise and Path Descent Profile (Instrument Approach using VNAV)



1 **Cruise**

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

2 **Descent**

After top of descent, FMC is in descent mode and VNAV changes to economy descent speed and descends in VNAV PTH.

3 **Speed Restriction Deceleration**

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV PTH.

When at restricted speed, VNAV commands decreased pitch and descends in VNAV PTH.

4 **Altitude Restrictions**

The VNAV path conforms to altitude restrictions at MNO, EPG, and the FAF. The thrust mode changes to FMC SPD as required to maintain the target speed.

5 **Approach**

VNAV descends and starts approach in VNAV PTH at the commanded speed.

6 **Missed Approach**

When TO/GA is pushed during approach, or when crossing the missed approach point, VNAV disengages.

When selected during missed approach, VNAV engages in VNAV SPD.

7 **Missed Approach Level Off**

At missed approach altitude VNAV changes to VNAV PTH.

Vertical Angle

A vertical angle can be assigned to a waypoint from the navigation database. This vertical angle defines a VNAV path between the waypoint and the waypoint preceeding it. This feature can be available in approaches, approach transitions, and STARs. For example, the vertical angle for the glideslope of an ILS approach would typically be 3 degrees. This angle is displayed on the ACT RTE LEGS page above the speed/altitude line for the associated waypoint. Vertical angles may be expected in any approach ending at RWXXX or MAXXX. The E/D will be RWXXX or MAXXX, and the E/D altitude will be either threshold crossing height (TCH – typically 50 feet above the touchdown zone elevation) or the altitude specified at MAXXX.

If a path (VNAV PTH) descent is active when a vertical angle leg becomes active, the path mode will remain active, but VNAV will follow the vertical angle rather than the idle thrust descent path.

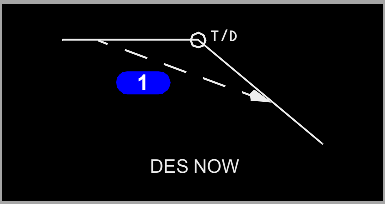
Early Descent

When in VNAV ACT DES, the FMC is considered to be in early descent when the airplane is below the computed descent path. VNAV commands a 1000 fpm descent until the idle descent path is intercepted or an FMC target altitude is complied with for any AT, or At-or-Above altitude constraints that exists in the flight plan, whichever occurs first i.e. idle descent path intercept or FMC target altitude compliance.

To start an early descent, use DES NOW prompt on the DES page.

A CRZ DES occurs when lowering the MCP ALT to a lower altitude, but at or above any descent constraint altitude and pressing ALT INTV if the airplane is further than 50 nm from the top of descent at the current cruise altitude. If within 50 nm of the top of descent, the Early Descent mode will be invoked.

- A cruise descent can be started by using the altitude intervention feature on the MCP when the airplane is not within a distance of 50 NM to the T/D, or by entering a new cruise altitude on the FMC CRZ page after setting the new level-off altitude in the MCP.
- Altitude Intervention may be used to initiate early descent when the airplane is 50 nm or less to Top of Descent.
- If Altitude Intervention is used to initiate descent when 50 NM or less to T/D and the MCP ALT below current altitude, or descent is initiated via DES NOW prompt on the DES page, Early Descent vertical speed commands of -1000 fpm are generated by the FMC for autopilot V/S tracking until path intercept, or next constraint altitude if altitude is reached when VNAV is engaged, or MCP ALT level off occurs.
- If Altitude Intervention is used to initiate descent when more than 50 NM to T/D with VNAV engaged and the MCP ALT below current altitude but at or above any descent constraint altitude, the result will be a cruise altitude reset to the MCP ALT and Cruise Descent vertical speed commands of -1000 fpm to the new cruise altitude.
- If Altitude Intervention is used to initiate descent when more than 50 NM to T/D with VNAV engaged and the MCP ALT below current altitude and below a descent constraint altitude, the result will be Early Descent vertical speed commands of -1000 fpm until path intercept or MCP ALT level off occurs.



1 DES NOW

VNAV starts an early descent at 1000 fpm and captures the idle descent path. VNAV uses FMC SPD for the autothrottle mode and VNAV PTH for the pitch mode.

Approach

The FMC transitions to “on approach” when the airplane is within:

- 2 NM of the first approach waypoint (including approach transitions such as arcs and procedure turns), or
- 2000 feet of airport elevation, whichever occurs first.

When the FMC is “on approach”, the following features are available:

- UNABLE RNP alerting levels are higher
- when preparing for a missed approach and the MCP altitude is set at least 300 feet above the current airplane altitude, VNAV remains in VNAV PATH.
- if the airplane is more than 200 feet below the vertical path, VNAV commands zero vertical speed until intercepting the path.

Note: Display of a specified path angle is not limited to approaches. A path angle may be defined for a leg in a STAR and displays on the RTE LEGS page for the procedure.

The FMC transitions out of “on approach” under the following conditions:

- selecting TO/GA
- the airplane lands
- the waypoint cycles to the first waypoint of the missed approach
- executing a direct-to waypoint in the missed approach.

The following situations are generally encountered during approach operations, but are not determined by “on approach” logic:

- If speed intervention is engaged:
  - during a path descent with flaps up on an idle or non-idle leg, VNAV switches to VNAV SPD
  - with flaps down, VNAV remains in VNAV PTH

- •when a point to point (geometric path) leg is active, VNAV remains in VNAV PTH
- •while a vertical angle leg (GP x.xx on RTE LEGS page) is active, VNAV remains in VNAV PTH
- if a vertical angle leg (GP x.xx on RTE LEGS page) becomes active, VNAV switches to VNAV PTH without pilot action
- if on a vertical angle leg, and cross track exceeds two times the RNP value, while LNAV is not engaged, VNAV will disengage.

VNAV will remain engaged at all flap settings, allowing approaches to be flown using the vertical angle guidance. Speed for final approach can be set on the APPROACH REF page.

If an ILS approach is flown in VNAV using vertical angle guidance, VNAV will disconnect when passing the GS–XXX point if G/S is armed, but it can be reengaged. If the GS–XXX point is deleted, VNAV will remain engaged throughout the approach.

For an approach without a runway waypoint on the RTE LEGS page, the VNAV path is calculated to the MDA or a calculated altitude at the missed approach point. The calculated altitude may be below the MDA to ensure a flight path angle and normal threshold crossing height.

Note: It is the flight crew’s responsibility not to descend below the MDA until adequate visual contact is achieved.

Integrated Approach Navigation (IAN)

Integrated Approach Navigation (IAN) provides the capability to fly most FMC instrument approaches utilizing a procedure similar to that for ILS approaches. No special aircrew action is required other than to line select a IAN compatible approach into the FMC flight plan.

During an IAN approach, the FMC provides:

- glide path (G/P) deviations from the defined VNAV vertical path to the missed approach waypoint
- glide path (G/P) is constructed on an angle that passes through the altitude constraint at the missed approach waypoint, and is the steeper of either the published angle, or the angle that clears the altitude constraint at the waypoint prior to the missed approach waypoint
- final approach course (FAC) deviations from the defined LNAV lateral path to the missed approach waypoint
- final approach course (FAC) only provides guidance to the runway if the missed approach waypoint is located at the runway approach end
- a source for the deviation scales
- distance to the missed approach waypoint.

The FMC also adds the following capabilities:

- IAN operations without valid PERF data (i.e. during a performance down-mode).
- display of vertical angle with or without PERF data on both active and inactive routes.

IAN can be used when the pilot defines a visual flight rule (VFR) approach by entering a flight path angle (FPA) on the Arrival (ARR) page when a runway is selected.

Adds functionality for IAN support for Pilot-Defined Final Approach by:

- allowing IAN to be used when the pilot defines a VFR approach by selecting a RWY #### and FPA on the Airport ARRIVALS page.
- correctly depicting the crew entered angle on the VSD.
- showning the angle above the respective leg on the ACT RTE X LEGS page.
- not changing the current operation of the FPA field. FPA field depicts a runway with a pilot-entered FPA the same as a runway with a vertical angle per the NDB.

The Integrated Approach Navigation (IAN) feature will allow any waypoint on a final approach to adjust the IAN angle of descent.

The crew can enter altitude restrictions on any waypoint on a final approach. These restrictions include:

- AT
- AT or ABOVE (will have the suffix "A" on the legs page) e.g., 12000A
- AT or BELOW (will have the suffix "B" on the legs page) e.g.,12000B
- WINDOW (will have the suffix "A" and "B", procedure only) e.g.,12000A13000B

Altitude restrictions entered will be used to shape the VNAV path but the IAN angle will be determined by the highest altitude (absolute value) which will result in the IAN path clearing all restrictions on the final approach path from the Final Approach Fix (FAF) to the Missed Approach Point (MAP).

Additionally, normal flight director steering bars are displayed that reflect G/P and FAC guidance.

IAN provides both lateral and vertical deviation for the following approaches:

- NDB
- NDB/DME
- RNV (RNAV)
- VOR
- VOR/DME
- GPS

IAN provides vertical deviations for the following approaches:

- BCS (BAC)
- ILS (G/S OFF)
- LOC

IAN approaches may be flown with or without the autopilot. At or above minimums, the pilot flying is expected to disengage the autopilot and manually complete the flare and touchdown. Both visual and aural alerts are provided if the autopilot remains engaged below 100 feet RA with either FAC or G/P engaged. "AUTOPILOT, AUTOPILOT" is annunciated over the flight deck speaker and an amber AUTOPILOT flashes over the attitude display.

Both RNP and VRNP are used to scale the displayed FAC and G/P deviations.

If the UNABLE REQD NAV PERF - RNP message is displayed on the MAP, IAN FAC and/or G/P deviation point will be sent invalid.

Lateral RNP may be revised from the RNP PROGRESS, RTE LEGS and POS SHIFT pages.

VRNP values may be revised on RNP PROGRESS page 4/5. The FMC will accept manual entry of a VRNP value greater than the default value, but the scratchpad message VERIFY VERT RNP VALUE will be displayed.

Manual entries are cleared at flight completion.

For additional IAN information, see chapters 4, 10, 15, and Normal Procedures in Volume 1.

Go-Around

Below 2000 feet radio altitude, the FMC transitions to go-around logic from approach logic when any of the following events occur:

- pushing either TO/GA switch while in a descent
- executing a direct-to waypoint in the missed approach (other than the missed approach point)
- automatically while in a descent and the last waypoint of the approach cycles to the first waypoint of the missed approach.
- the airplane climbs at a vertical speed greater than 600 fpm and the flaps are retracted from a landing setting toward a flap setting of 15 or 1

Once the FMC go-around logic is established:

- the FMC transitions from active descent to active climb
- the thrust limit changes to go-around thrust

- all descent altitude constraints below the current airplane altitude are deleted and replaced with predicted altitudes
- the original destination airport (airport from which the go-around was just initiated) becomes the new origin airport allowing SID selection if a diversion to another airport is required.

Note: LNAV may be engaged when the airplane climbs above 400 feet radio altitude, but VNAV should not be engaged until after flap retraction.

If the go-around was initiated by pushing a TO/GA switch or selection of go-around thrust, the CRZ ALT will change to the highest of:

- the highest constraint in the missed approach
- 1500 feet above airport elevation
- the MCP altitude.

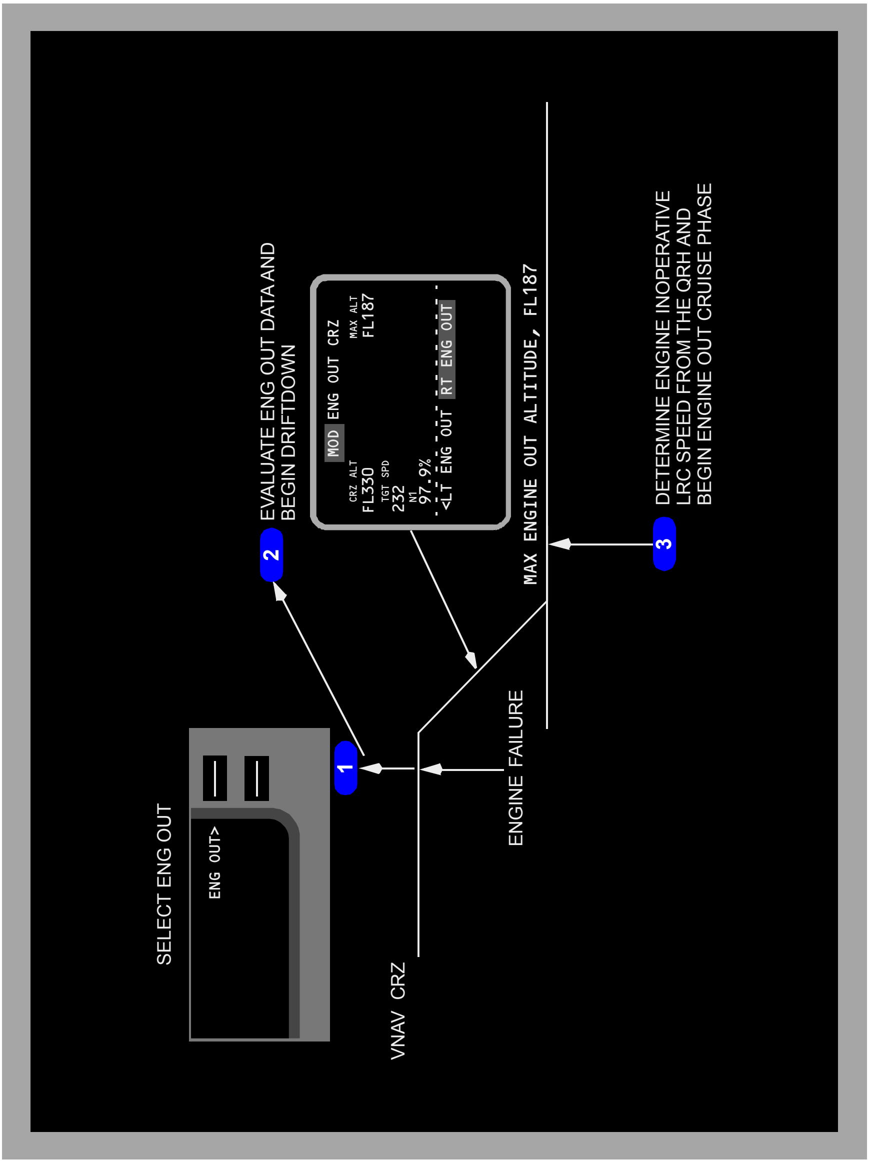
Note: If the MCP altitude is the lowest of the three, the autopilot, if engaged, will level off at the MCP altitude.

If the go-around was initiated by direct-to or waypoint sequencing, the CRZ ALT will change to the highest of:

- the highest constraint in the missed approach
- 1500 feet above airport elevation.

Refer to section NP21.xx, Go-Around Procedure and section 4.20, Go-Around for additional information.

VNAV Cruise (Engine Out Above Eng Out Max Alt)



1 Engine Out Modification

Select the ENG OUT prompt on the CRZ page. The ENG OUT page displays the appropriate engine out driftdown performance data to enable the airplane to descend to the engine out maximum altitude. Refer to FMC Cruise, section 11.42 for a complete description of the ENG OUT CRZ page.

2 Drift Down Execution

After selecting the left or right ENG OUT mode, perform the driftdown as follows:

- disengage A/T
- set maximum continuous thrust on operating engine (N1 line)
- set MCP speed to ENG OUT SPD
- set MCP altitude to MAX ALT or lower altitude as required
- select LVL CHG.

The airplane then descends at CON thrust and the driftdown airspeed to the MAX ALT. As the driftdown proceeds and airplane gross weight decreases, the maximum altitude may increase.

Note: The engine out cruise page provides advisory performance data for operating with one engine.

3 Engine Out Cruise

Engine out cruise operates like normal cruise with engine out cruise speeds. If range is a factor, determine Engine Inoperative LRC speed from the QRH. Thrust limit remains in CON.

Required Time of Arrival (RTA)

VNAV controls cruise speed to achieve a flight crew specified arrival time at a specified waypoint. After the appropriate waypoint and RTA are input to the FMC, the FMC will compute a recommended takeoff time, speeds required to comply with the RTA, and progress information for the flight. If the RTA is not achievable, the RTA UNACHIEVABLE scratchpad message is displayed.

Data Entry Rules

Altitude Entry

Altitudes can be entered into the FMC as three digit (xxx), four digit (xxxx), five digit (xxxxx), or flight level (FLxxx) numbers. The FMC automatically displays altitude or flight level entries in the proper form based on the transition altitude. Some data lines further restrict the valid entry forms.

Three digit entries represent altitude or flight levels in increments of 100 feet. Leading zeros are required.

Examples of three digit (xxx, FLxxx) entries with transition altitude = 10,000 feet:

- 800 feet is entered as 008 or FL008 and displayed as 800
- 1,500 feet is entered as 015 or FL015 and displayed as 1500
- 11,500 feet is entered as 115 or FL115 and displayed as FL115
- 25,000 feet is entered as 250 or FL250 and displayed as FL250.

Four digit entries represent feet, rounded to the nearest ten feet. Leading zeros are required. This form is used when the altitude does not exceed 9,994 feet.

Examples of four digit (xxxx) entries with transition altitude = 18,000 feet:

- 50 feet is entered as 0050 and displayed as 50
- 835 feet is entered as 0835 and displayed as 840
- 1,500 feet is entered as 1500 and displayed as 1500
- 8,500 feet is entered as 8500 and displayed as 8500
- 9,994 feet is entered as 9994 and displayed as 9990.

Five digit entries represent feet, rounded to the nearest ten feet. This form is used when the altitude exceeds 9,994 feet.

Examples of five (xxxxx) digit entries with transition altitude = 4,000 feet:

- 50 feet is entered as 00050 and displayed as 50
- 835 feet is entered as 00835 and displayed as 840
- 1,500 feet is entered as 01500 and displayed as 1500
- 8,500 feet is entered as 08500 and displayed as FL085
- 9,995 feet is entered as 09995 and displayed as FL100
- 11,500 feet is entered as 11500 and displayed as FL115
- 25,000 feet is entered as 25000 and displayed as FL250.

Negative altitude entries are allowed to –1000 feet.

Airspeed Entry

Airspeeds can be entered into the FMC as calibrated airspeed or Mach number. Calibrated airspeeds are entered as three digits (xxx) in knots. Mach numbers are entered as one, two, or three digits following a decimal point.

Data Pairs

Many CDU pages display data in pairs separated by a slash "/." Examples of these pairs include wind direction/speed and waypoint airspeed/altitude restrictions. When entering both values in a pair, the slash is inserted between the values. When it is possible to enter only one value of the pair, the slash may not be required. When entering only the outboard value of a pair, the trailing or leading slash may be entered, but is not required before transferring to the data line. When entering the inboard value of a pair, the trailing or leading slash must be entered before transferring to the data line. Omission of the required slash normally results in an INVALID ENTRY message.

Bearing Entry

Entry of a bearing value requires three digits. For example, key 090, not 90. A bearing entry of 360 is displayed as 000.

Plus/Minus Signs

When entering temperature or an along–track displacement distance, positive values are assumed by the FMC and + signs are not required. For negative values, key in the – sign.

Intentionally
Blank

FMC Databases

The FMC contains two databases:

- performance database
- navigation database.

The performance database eliminates the need for the flight crew to refer to a performance manual during flight, and provides the FMC with the information required to calculate pitch and thrust commands. All information normally required can be displayed on the CDU. The database includes:

- airplane drag and engine characteristics
- maximum and optimum altitudes
- maximum and minimum speeds.

Maintenance personnel can refine the database by entering correction factors for drag and fuel flow.

The navigation database includes most information normally determined by referring to navigation charts. This information can be displayed on the CDU or navigation display. The database contains:

- the location of VHF navigation aids
- waypoints
- airports
- runways
- other airline selected information, such as SIDs, STARs, approaches, and company routes.

If the permanent database does not contain all of the required flight plan data, additional airports, navaids, and waypoints can be defined by the crew and stored in either a supplemental or a temporary navigation database. Use of these additional databases provides world–wide navigational capability, with the crew manually entering desired data into the FMC via various CDU pages. Information in the supplemental navigation database is stored indefinitely, requiring specific crew action for erasure; the temporary navigation database is automatically erased at flight completion.

The supplemental and temporary databases share storage capacity for forty navaids and six airports, the entries being stored in either database on a first come, first served basis. For the waypoint category, exclusive storage is reserved in the temporary database for twenty entries (including those created on the RTE or RTE LEGS pages). An additional twenty waypoints (up to a maximum of forty) can be stored in either the temporary or supplemental database on a first come, first served basis.

When any storage capacity is full, entries which are no longer required should be deleted by the crew to make space for additional new entries. Created waypoints cannot be stored in the database runway category.

The FMC contains two sets of navigation data, each valid for 28 days. Each set corresponds to the normal navigation chart revision cycle. The FMC uses the active set for navigation calculations. The contents of the navigation database are periodically updated and are transferred to the FMC before the expiration date of the current data.

Thrust Management

The autothrottle operates in response to flight crew mode control panel inputs or to automatic FMC commands. Reference thrust can be selected on the N1 LIMIT page. Automatic FMC autothrottle commands are made while VNAV is engaged. The autothrottle system:

- uses reference thrust limits calculated by the FMC
- commands the thrust levers
- commands thrust equalization through the electronic engine controls.

Thrust limits are expressed as N1 limits. Thrust equalization references N1.

The FMC calculates a reference thrust for the following modes:

- takeoff
- derated takeoff
- assumed temperature takeoff
- takeoff bump (as installed)
- climb
- reduced climb
- cruise
- continuous
- go–around.

The thrust reference mode automatically transitions for the respective phase of flight. These modes can be selected on the N1 LIMIT page. The selected thrust reference mode is displayed on the thrust mode display.

The flight crew can specify the thrust reduction height where the transition from takeoff to climb thrust takes place by making an entry on TAKEOFF REF page 2. Allowable entries are 800 feet to 9,999 feet.

The default value is determined by the airline and is stored in the model/engine database.

Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extend engine life. They are used whenever performance limits and noise abatement procedures permit.

Takeoff Derate

Fixed derates can be selected on the N1 LIMIT page. Performance data for these derates is provided in the Airplane Flight Manual (AFM).

With derated takeoff selected, the thrust setting parameter is considered a limitation for takeoff; therefore, thrust levers should not be advanced further except in an emergency. A further thrust increase following an engine failure could result in a loss of directional control while on the ground. Use the takeoff speeds supplied by the FMC or specified in Chapter PI, Performance-Inflight, for the selected derate condition.

Derated takeoff rating can be further reduced by assumed temperature.

Use the takeoff speeds specified in Chapter PI, Performance–Inflight, for the selected derate or variable takeoff rating condition.

Assumed Temperature Thrust Reduction Takeoff

A takeoff thrust less than the full rated thrust may be achieved by using an assumed temperature that is higher than the actual temperature. The desired thrust level is obtained through entry of a SEL TEMP value on the N1 LIMIT page or TAKEOFF REF page 2. Use approved sources for selecting the assumed temperature.

The maximum thrust reduction authorized is 25 percent below any certified rating. Do not use assumed temperature reduced thrust if conditions exist that affect braking, such as slush, snow, or ice on the runway, or if potential windshear conditions exist.

When the assumed temperature method is used with full rate, the reduced thrust setting is not considered a limitation. If conditions are encountered where additional thrust is desired, the crew can manually apply full thrust.

Takeoff Bump Thrust

(as installed)

Takeoff bump thrust may be used to meet extra thrust requirements for takeoff at certain airports. Takeoff bump thrust provides thrust above normal maximum takeoff thrust. The takeoff thrust bump setting may be selected on the N1 LIMIT page. If takeoff thrust bump is selected, assumed temperature reduced thrust is not available.

Bump thrust is available for takeoff thrust, and is the applied thrust rating for Go-around thrust. Thrust bump is not applied to max continuous or climb thrust ratings.

Derated Thrust Climb

Two fixed climb thrust derates can be selected on the N1 LIMIT page. CLB–1 provides a climb limit reduced by 3% N1 (approximately 10% thrust). CLB–2 provides a climb limit reduced by 6% N1 (approximately 20% thrust). The reduced climb setting gradually increases to full rated climb thrust by 15,000 feet. In cruise, the thrust reference automatically changes to CRZ. The reference can be manually selected on the N1 LIMIT page.

Use of an assumed temperature reduced thrust takeoff or takeoff derate affects the FMCs climb derate computation. If a reduced thrust takeoff has been specified on the TAKEOFF REF page, the FMC will re-compute CLB-1 and CLB-2 values as required to avoid a climb N1 value greater than the reduced thrust takeoff N1 value.

Use of derated climb thrust reduces engine maintenance costs, but increases total trip fuel.

Fuel Monitoring

The FMC receives fuel quantity data from the Fuel Quantity Indicating System (FQIS) or from manual entries on the CDU. The fuel quantity source is selected on PROGRESS 5/5 page. Selections include a TOTALIZER (6L) and CALCULATED (6R). TOTALIZER is the default value.

To indicate the source of fuel being used for FMC calculations the PERF INIT page includes the following suffix labels:

- CALC (Calculated): The FMC will generate a CALCULATED fuel value using input data from the FQIS, engine Fuel Flow data from the EECs, and fuel flow data from the APU. The 2L data field will display CALC if the fuel weight is sourced from the FMC Calculated value.
- MAN (Manual): Manual entry of fuel is allowed when the FMC CALC fuel is the source and engines are running (or when dashes or box prompts are displayed in 2L). Prior to engine start, the calculated value is set to agree with and track the FQIS value if it is valid or to prompt for a manual fuel entry if it is not (box prompts will be displayed in 2L).
- SENS (Sensed): If TOTALIZER is the selected system fuel value then SENS is displayed in the PERF INIT 2L data field.
- PLAN: Fuel entries are also permitted before engine start if the PLAN fuel FMC option is activated. PLAN fuel entries facilitate pre-flight calculations of takeoff speeds and trip fuel predictions based on anticipated takeoff fuel load and GW. PLAN fuel entries are deleted at engine start and are replaced by totalizer fuel quantity if valid or else by a manual fuel entry.

When the FMC receives a positive fuel flow signal at engine start, the calculated value is disconnected from the FQIS and decreases at the fuel flow rate as received from the Electronic Engine Controllers. This fuel quantity value is displayed on the PROGRESS 5/5 page as CALCULATED (6R).

Following engine shutdown, FUEL QTY values remain displayed, but are reset to ZERO when the FMC receives a positive fuel flow at the next engine start.

Pilot entry of a fuel quantity value is permitted on the PERF INIT 2L data field after engine start when CALCULATED fuel is selected as the active system fuel and results in the entered value being displayed with MAN to show the source. The manual value is then updated by the FMC using fuel flow.

If fuel flow data becomes invalid after engine start, the calculated value will be considered invalid and the FQIS quantity will be used by the FMC for performance computations. In this case, fuel quantity will be displayed as SENS on the PERF INIT page and the TOTALIZER value on PROGRESS 5/5 page will be <ACT>.

After engine start, the FMC snap shots the total fuel load on board as provided by the FQIS and calculates a fuel value using fuel flow inputs from the EECs.

The Engine Display advisory message FUEL DISAGREE is displayed if the FMC determines a difference (exceeds the MEDB specified value for more than 5 continuous minutes) between the total sensed fuel quantity and calculated fuel quantity values.

The FMC continually computes the amount of fuel that will remain when the destination airport is reached if the active route is flown. The Engine Display advisory message INSUFFICIENT FUEL is displayed if the fuel remaining at destination is less than 900 kg.

The USING RESERVE FUEL Engine Display Advisory message is displayed when a change in flight conditions or route causes the predicted fuel remaining at the destination is less than the total fuel on board minus the crew entered reserves for the active flight plan.

The FUEL DISAGREE, INSUFFICIENT FUEL and USING RESERVE FUEL messages will also show in the CDU scratchpad, illuminate the FMC light as well as appearing on the Engine Display. Clearing the scratchpad message will extinguish the FMC light. However, the message will remain (persist) on the Engine Display until the condition is resolved.

The FMC also provides the trigger logic and indication for the FUEL FLOW (for engine 1 or engine 2) indication displayed as an MDS Korry light message on the Engine Display. The light is illuminated when the difference between the calculated fuel flow and the measured fuel flow exceeds the MEDB defined threshold and the fuel difference detection has been set continually for five minutes for either engine.

The scratchpad message VERIFY GW AND FUEL shows if total fuel quantity data is invalid. The PERF INIT page FUEL line changes to dashes. The FMC uses the last valid fuel quantity for performance predictions and VNAV operation. The flight crew should manually enter estimated fuel weight. Periodic fuel weight update is required for the remainder of the flight to keep gross weight current. The FMC does not update the manual fuel weight entry. The scratchpad message VERIFY GW AND FUEL shows again each 30 minutes if subsequent entries are not performed. The scratchpad message does not show during descent with Vref selected.

The scratchpad message CHECK FMC FUEL QUANTITY shows if the FMC has detected an unexpected drop in fuel quantity.

Loss of FMC Electrical Power

The FMC requires continuous electrical power to operate. When the electrical power is interrupted for less than ten seconds:

- LNAV and VNAV disengage
- all entered data is retained by the FMC
- the FMC resumes normal operation when power is restored.

If power is lost for ten seconds or more on the ground, all preflight procedures and entries must be done again when power is restored.

If power is lost for more than ten seconds in flight:

- LNAV and VNAV disengage
- all entered data is retained by the FMC, and when power is restored the RTE LEGS page is displayed with the scratchpad message SELECT ACTIVE WPT/LEG.

Before LNAV can engage, the FMC must be instructed how to return to the route. Select the desired active waypoint and proceed direct or intercept a course to the waypoint.

FMC Failure

Single FMC Failure

The FMC/CDU is designed to automatically preserve the most capable modes of navigation and guidance that can be maintained with the equipment and navigation aids available. If an error or system failure results in reduced capability, then the FMC may generate a crew message for display in the CDU scratchpad. If other system inputs to the FMC should fail, affected CDU displays are blanked to prevent the display of misleading or erroneous data. For example, loss of the total fuel input causes some performance related data to be blank. The messages and FMC internal responses provide an orderly transition from full FMC guided flight to less automated capability.

If the right FMC fails, the FMC alert light and the FMC message light will illuminate. The message SINGLE FMC OPERATION will be displayed in both scratchpads. VTK will display on the right navigation display. LNAV and VNAV will disengage if autopilot B is in use (can be reengaged if autopilot A is selected). After 25 to 30 seconds, the right navigation display will display failure information. The right navigation display may be restored by placing the FMC source select switch to BOTH ON L.

If the left FMC fails, the FMC alert light will illuminate. The MENU page will appear on both CDUs. VTK will appear on the left navigation display. LNAV and VNAV will disengage, but can be reengaged if autopilot B is in use or is selected. After 25 to 30 seconds, the left navigation display will display failure information. To restore full operation, the FMC source select switch must be moved to BOTH ON R.

Note: During an FMC software restart, the navigation display map track may rapidly slew to 0 degrees then to the correct value.

Dual FMC Failure

If both FMCs fail, the FMC alert light will illuminate. The MENU page will appear on both CDUs. VTK will appear on both navigation displays. LNAV and VNAV will disengage. After 25 to 30 seconds, both navigation displays will display failure information.

Software Exception Handling Logic

Note: A Software Exception is the disruption in the normal flow execution of the software code; i.e. an attempt to solve an unsolvable map calculation.

The software exceptions handling logic will prevent a complete FMC restart in the event of most software exceptions. If performance data is entered, an exception in most processing will result in a downgrade of FMC operation, not a complete loss of function.

In the downgrade mode:

- LNAV and Map are retained
- FMC Predictions are halted
- VNAV is disconnected

If the software exception occurs in processing of the active flight plan, an alerting level message, VNAV INVALID - PERF, will be displayed for the pilot indicating re-entry of Cost Index is required in order to restart the internal software predictions process, which is required before reengagement of VNAV. Predictions can be restarted allowing VNAV to be reengaged after entry and EXEC of Cost Index on the PERF INIT page.

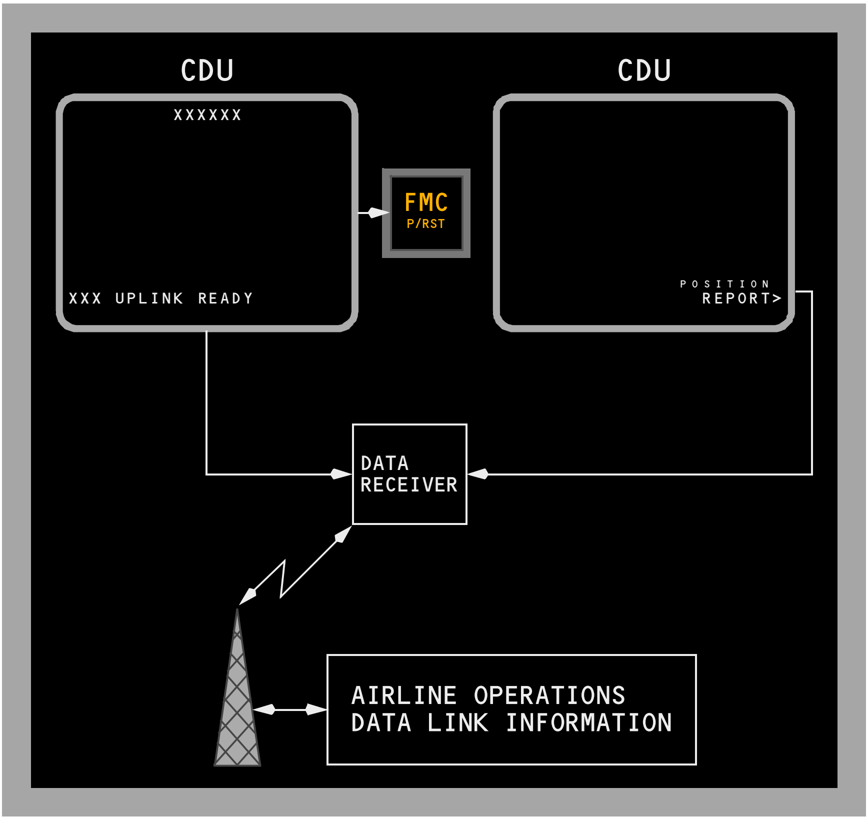
When a software reset occurs in the MOD PLAN and not the ACT PLAN, the FMC will delete the MOD PLAN. An advisory message, INVALD MOD PLAN, will be displayed for the pilot indicating that this has occurred. LNAV and VNAV will remain engaged for this case.

When a software reset occurs in an INACTIVE PLAN, the FMC will delete the INACTIVE PLAN. An advisory message, INVALD INACTIVE PLAN, will be displayed for the pilot indicating that this has occurred.

This improvement will not prevent all restarts; it does not cover those that may leave the FMC's memory in an inconsistent state.

Company Data Link

The airplane communications system enables two–way data link communications between the FMC and airline operations. A downlink occurs when data is transferred from the FMC and transmitted through the airplane communications system to a receiver on the ground. Data may be downlinked from the FMC either manually or automatically. An uplink is the opposite of a downlink; data is transmitted from a ground station for input to the FMC. Data may be uplinked at the discretion of the airline operations dispatcher or in response to a downlink request.



Data Link

Downlinks are data link messages transmitted to a ground station. Requests for data and reports of FMC information are two types of downlinks. Requests are made manually by the flight crew. Reports can be made manually or may occur automatically.

Uplinks are messages transmitted to the airplane. Most uplinks require manual selections by the flight crew. Some uplinks are input automatically.

Manual Downlinks

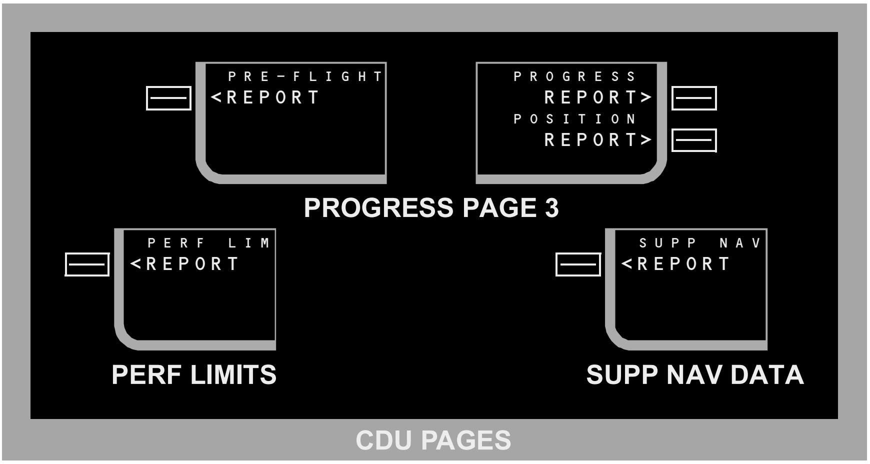
Select a REQUEST prompt to start the downlink request for data. REQUEST prompts are on PERF INIT, PERF LIMITS, TAKEOFF REF, PROGRESS, DES FORECASTS, RTE, ALTERNATE DEST, RTE DATA, and SUPP NAV DATA pages. Downlink reports of the active route may be accomplished by selection of the REPORT prompt on the PERF LIMITS or PROGRESS page and a position report may be downlinked by selection of the REPORT prompt on the PROGRESS page. The contents of the supplemental navigation database can be downlinked by selection of the REPORT prompt on the SUPP NAV DATA page.

When the communications function is unable to process FMC downlinks, the words FAIL, VOICE, NO COMM, or FULL are displayed on the CDU pages in place of the REQUEST and REPORT prompts and the header line displays the word DATALINK. The status messages are:

- FAIL – the ACARS management unit is inoperative
- VOICE – radio is operating in the VOICE mode
- NO COMM – radio is operational but not available
- FULL – all available downlink space is full.

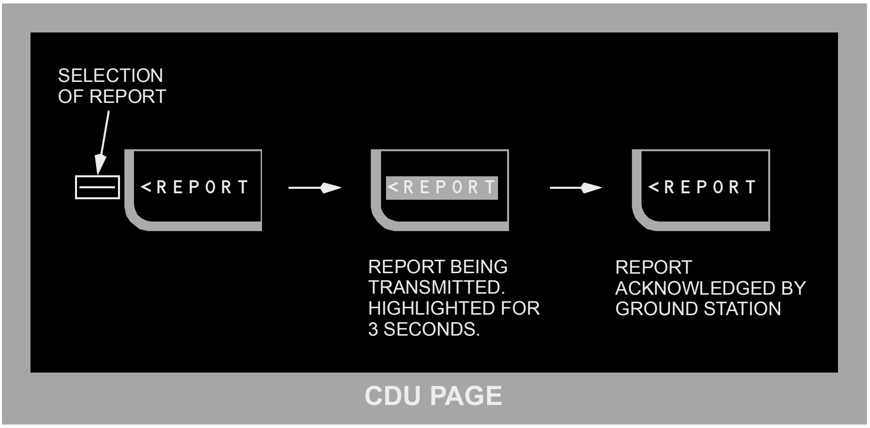
Reports

A REPORT prompt on each page downlinks a unique report applicable to that page. The pages below contain report prompts.



Report Status

Below is a typical sequence of status in response to sending a report.



Automatic Downlinks

The FMC can be configured by the airline to automatically transmit downlinks of FMC data at predetermined points during the flight or in response to specific information requests from the airline dispatcher. The FMC response in these cases is completely automatic and no crew action is necessary.

Uplinks

Uplinked data may be loaded automatically or may require flight crew action. Three uplinks automatically load data into the FMC when the REQUEST prompt is selected and do not require execution.

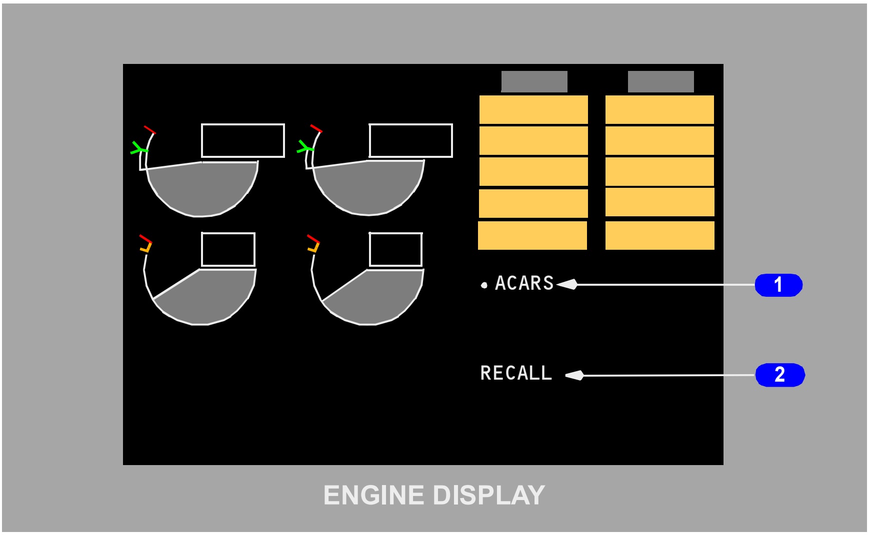
Uplinked data that waits in system memory for flight crew action are considered to be pending. A pending uplink is included or discarded when the flight crew selects the applicable prompt. Flight crew response to an uplink depends on the type of uplink. Flight crew action is made with ACCEPT/REJECT or LOAD prompts, FMC modification ERASE prompt or EXEC key, or when the page with the uplink is selected.

Data can be uplinked from the airline dispatcher directly to the FMC. The uplinks are annunciated to the crew on the engine display. The uplink is identified by a CDU scratchpad message.

PERF INIT uplinks are available only on the ground and after an origin airport has been entered on the RTE page.

RTE DATA cruise winds are available when not in descent and a cruise altitude and a flight plan route exist.

DES FORECASTS winds are available if a cruise altitude exists.



1 •ACARS Uplink Message (white)

Indicates receipt of an uplinked ACARS message. The uplink is identified by a CDU scratchpad message.

2 **•RECALL (white)**

Recalls Communication messages.

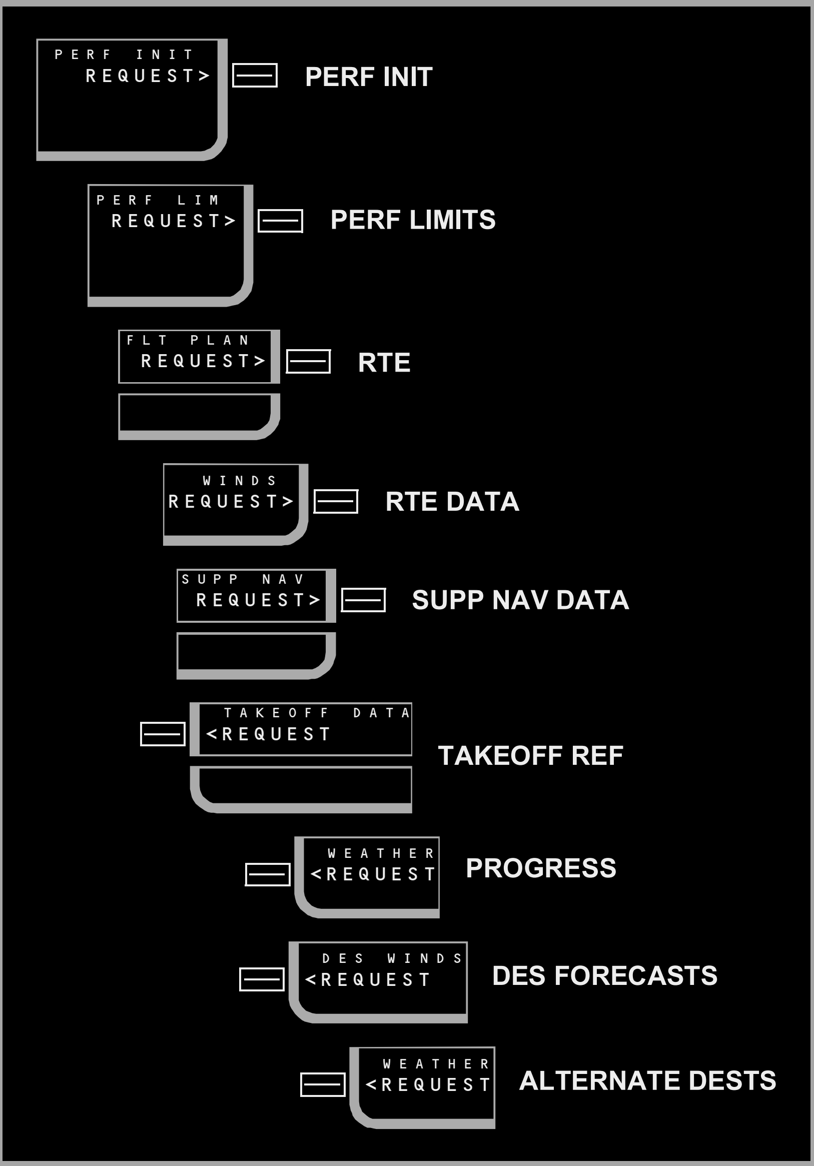
Long Delete Function

During uplink, CDU keys are ignored until data is loaded into the FMC. The uplink may be suspended by pressing and holding down the DEL key for at least one second. For all uplinks, except SUPP NAV DATA uplinks, the loaded data is then removed from the flight plan and placed back into the ready to be loaded state.Uplinks that do not generate a modified plan are reloaded when there has been no CDU pushbutton activity for 30 seconds. Uplinks that do generate a modified plan can be reloaded using the LOAD prompt on the appropriate page.

When the long delete is used during a SUPP NAV DATA uplink, the uplink is suspended, but the data loaded up to that point remains in the database. After 30 seconds of keyboard inactivity, the remaining data is loaded.

Requests

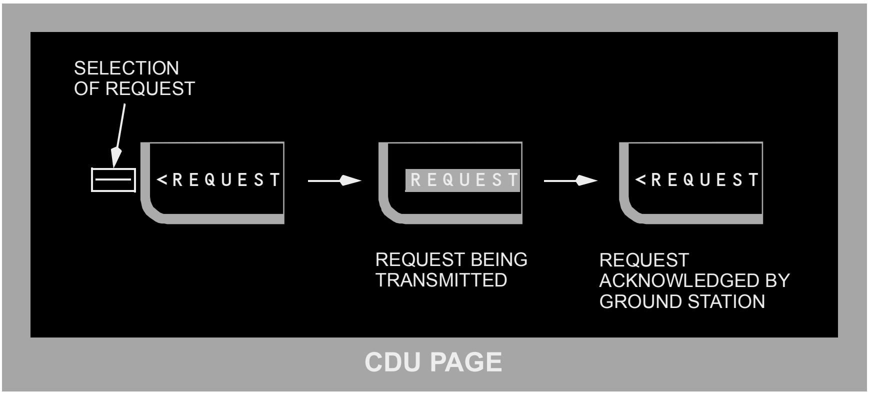
A REQUEST prompt on each page downlinks a unique request applicable to that page. The pages below contain request prompts.



CDU PAGES

Request Status

Below is a typical sequence of status in response to sending a request.



FMC Data Link Uplinks (Accept/Reject)

ACCEPT and REJECT are shown on the TAKEOFF REF 1/2 page following receipt of uplink data.

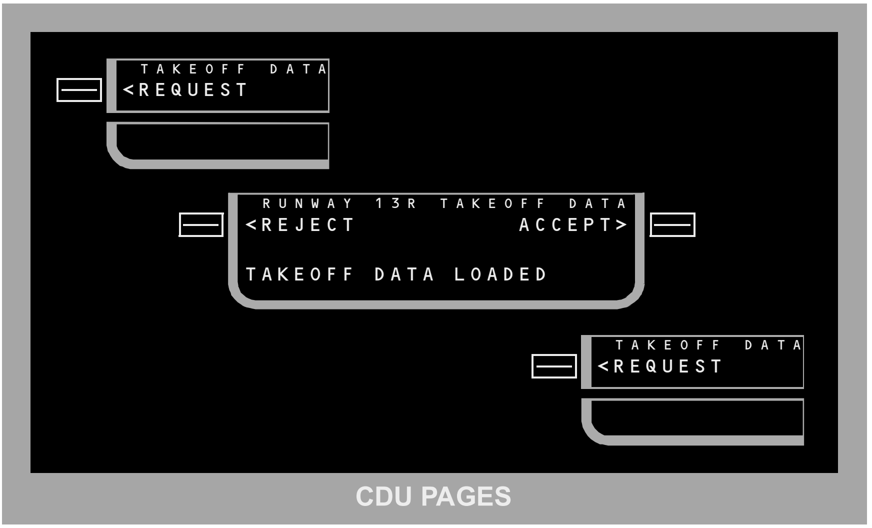
Uplink data for the current runway is shown initially in small font for preview.

Selecting ACCEPT:

- displays uplinked data in large font
- replaces previous data with uplinked data
- returns page display to normal (pre–uplink) format
- clears scratchpad message
- transmits a downlink accept message (if enabled) to acknowledge acceptance.

Selecting REJECT:

- replaces uplinked data with previous data
- returns page display to normal (pre–uplink) format
- clears scratchpad message
- transmits a downlink reject message (if enabled) to inform of rejection.



FMC Data Link Uplinks (Load/Activate/Exec)

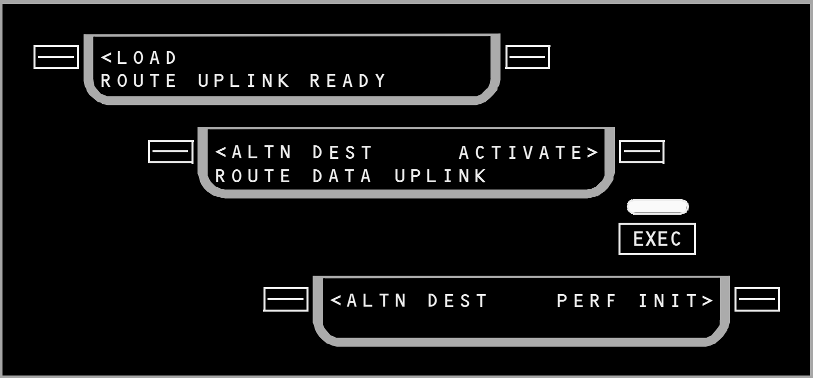
LOAD is shown on the RTE page after receipt of uplink data. After the uplinked data is loaded, the ACTIVATE prompt is shown. After selecting ACTIVATE, the EXEC light illuminates.

Selecting LOAD:

- loads uplinked data into FMC for viewing
- updates scratchpad message
- transmits a downlink accept message (if enabled) to acknowledge acceptance.

Selecting ACTIVATE and EXEC:

- puts uplinked data in active flight plan
- returns page display to normal (pre–uplink) format
- clears scratchpad message
- transmits a downlink accept message (if enabled) to acknowledge acceptance.



CDU PAGES

FMC Data Link Uplinks (Load/Exec–Erase)

LOAD shows on the PERF INIT, PERF LIMITS, RTE DATA, and DES FORECASTS pages after receipt of uplink data.

After the uplinked data is loaded, the EXEC light illuminates and the ERASE prompt is displayed.

Selecting LOAD:

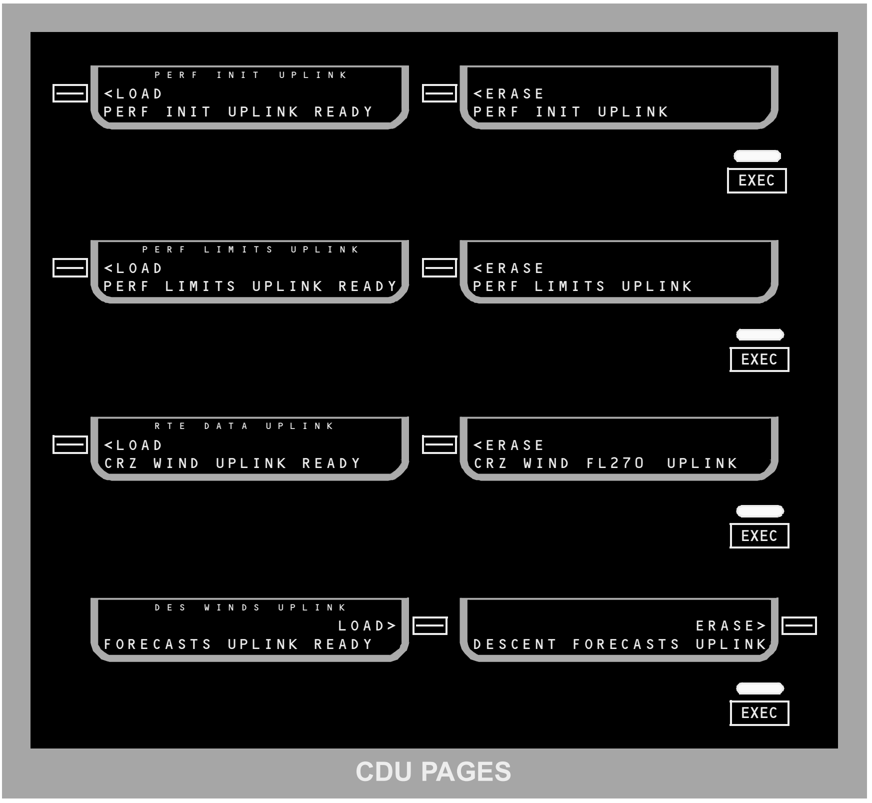
- loads uplinked data into FMC for viewing
- updates scratchpad message
- uplinked data modifies previous data
- ERASE prompt displays
- EXEC light illuminates.

Pushing the EXEC key:

- incorporates modified data into active flight plan
- clears scratchpad message
- returns page display to normal (pre–uplink) format
- transmits a downlink accept message (if enabled) to acknowledge acceptance.

Selecting ERASE:

- removes modified data
- clears scratchpad message
- returns page display to normal (pre–uplink) format.
- transmits a downlink reject message (if enabled) to inform of rejection.



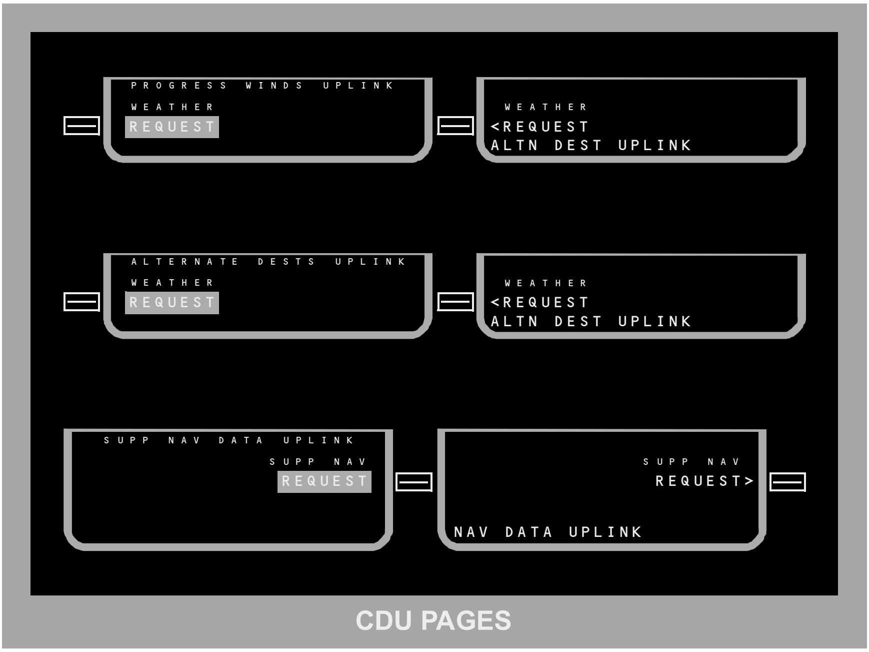
FMC Data Link Uplinks (Request)

Selecting the REQUEST prompt is the only action required to uplink data on the PROGRESS, ALTERNATE DEST, and SUPP NAV DATA pages.

After the uplinked data is loaded, an uplink message appears in the scratchpad.

Selecting REQUEST:

- loads uplinked data into FMC
- displays scratchpad message when uplink complete
- uplinked data modifies previous data.



FMC Data Link Uplinks (Automatic)

Data can be automatically uplinked.

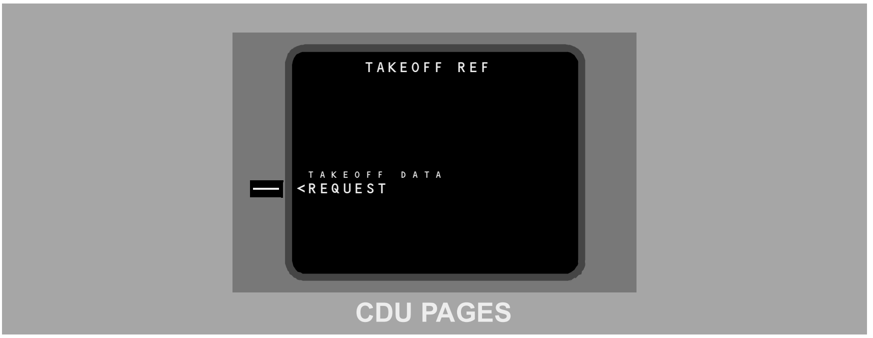
The scratchpad message XXXXX UPLINK READY is displayed and the FMC alert light illuminates.

Data Link Management

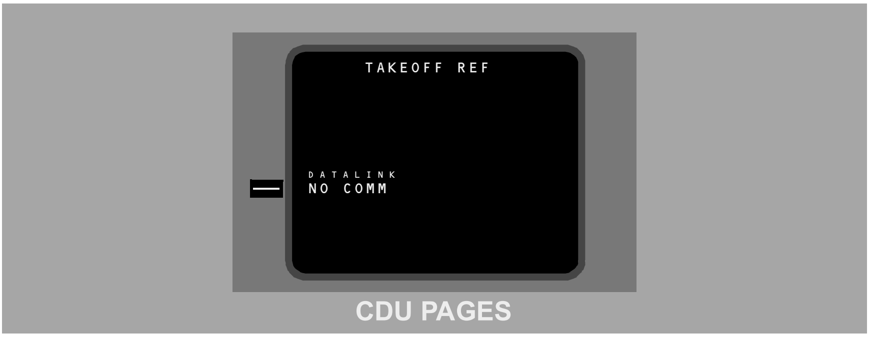
The flight crew should monitor system status of FMC data link by observing status displays on CDU pages.

CDU Data Link Status Displays

Data link operation is verified when the correct line title is above the related prompt. In the example below, the line title TAKEOFF DATA is above the REQUEST prompt on the TAKEOFF REF page.

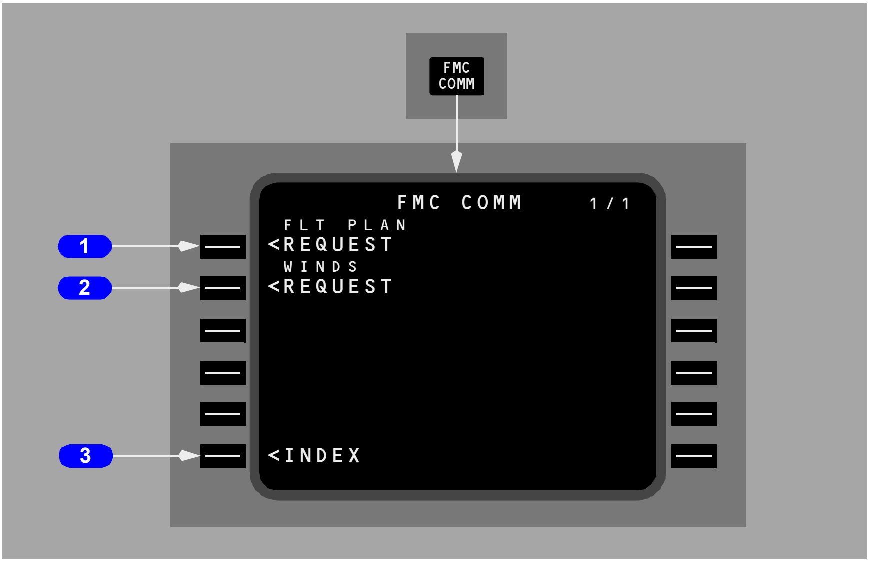


When the data link system is not operating, CDU page prompts change to FAIL, VOICE, NO COMM or FULL and the headings change to DATALINK. A typical example is shown below.



FMC Communications Page

FMC communication page provides ability to initiate AOC datalink downlink requests. The actual prompts available and types of information requests generated is customer definable. The page examples below are representative only.



1 Flight Plan Request (FLT PLAN)

Push – transmits a data link request for a flight plan uplink.

2 Winds Request (WINDS)

Push – transmits a data link request for a winds uplink.

3 INDEX

Push – displays the INIT/REF INDEX page.

Navlink ACARS

ACARS (Aircraft Communication Addressing and Reporting system) is a system that provides for the transmission of digital data to and from aircraft via VHF, HF and SATCOM subnetworks. These messages, referred to as uplinks and downlinks, facilitate two-way communication for applications such as digital ATIS, clearances, weather/turbulence reports, delay reports and free text messaging with airline Dispatch and Maintenance. Other applications include automated OOOI (Out-Off-On-In) reports, engine data reports, position reports, gate assignment uplinks, and connecting gate uplinks, just to name a few.

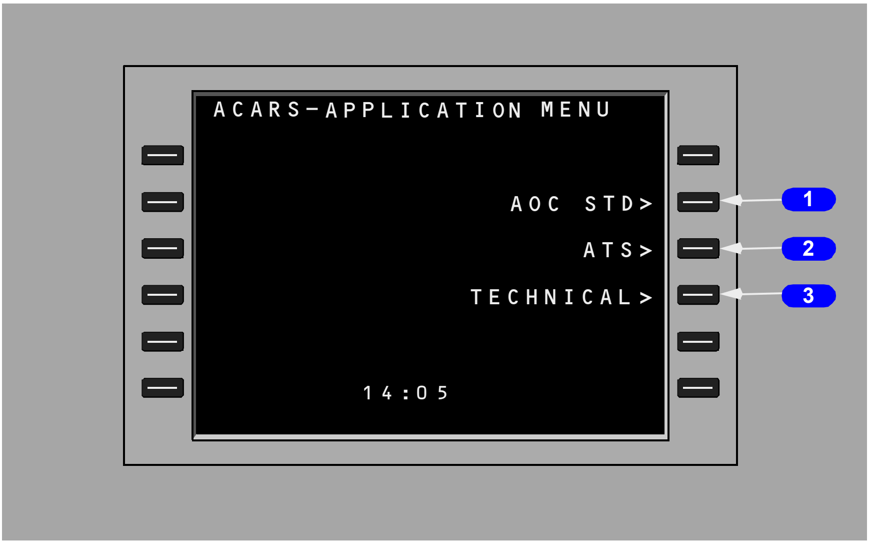
Note: The following section describes the manufacturer provided ACARS system. Each customers airplanes can be equipped with a dedicated company ACARS system that may differ from the following pages.

The CMU 900 system can include three software applications: the Airline Operational Control (AOC), Air Traffic Services (ATS), and the Technical applications.

The Navlink portion of the Airplane Communication Addressing and Recording System (ACARS) provides upload and download capability for preflight and in flight information.

Navlink ACARS access is gained by selecting the ACARS prompt on the MENU page. This temporarily suspends the FMC functions of the CDU and allows the CDU to be used by the Navlink ACARS system.

Application Menu Page



1 Airline Operational Control STD (AOC STD)

Push – selects ACARS – AOC MENU.

2 Air Traffic Services (ATS)

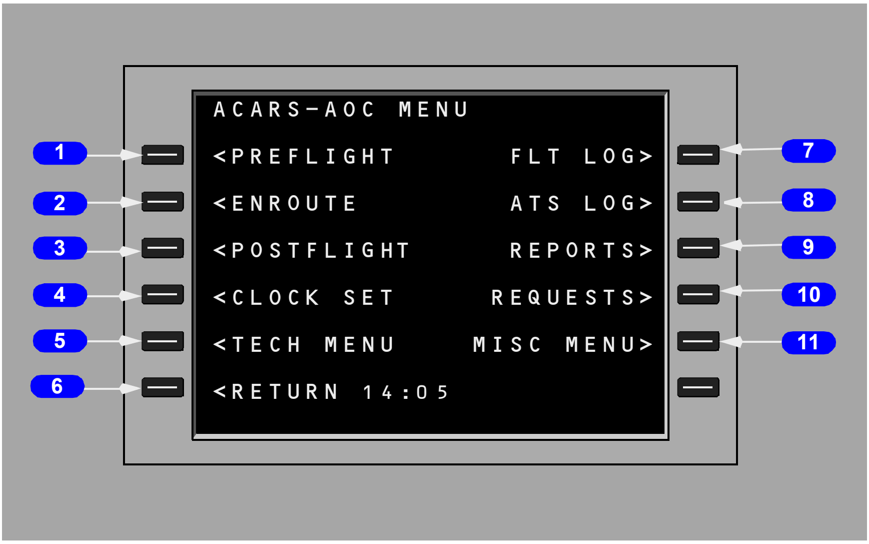
Push – selects ATS – ATS MENU

3 TECHNICAL

Push – selects ACARS – TECHNICAL MENU page. This menu provides access to functions such as diagnostics, link maintenance, and other functions not normally accessed during a flight leg.

Navlink ACARS AOC Menu Page

The AOC MENU page is the initial AOC application page. It provides ten page selects.



1 PREFLIGHT

Push – select PREFLIGHT menu page.

2 ENROUTE

Push – selects ENROUTE menu page.

3 POSTFLIGHT

Push – selects POSTFLIGHT page.

4 CLOCK SET

Push – selects CLOCK SET page.

5 TECH MENU

Push – selects TECH MENU page.

6 RETURN

Push – selects the top page from the CDU page stack. The AOC application defines the return prompt text.

7 FLT LOG

Push – selects FLT LOG page.

8 ATS LOG

Push – selects ATS LOG page.

9 REPORTS

Push – selects REPORTS page.

10 REQUESTS

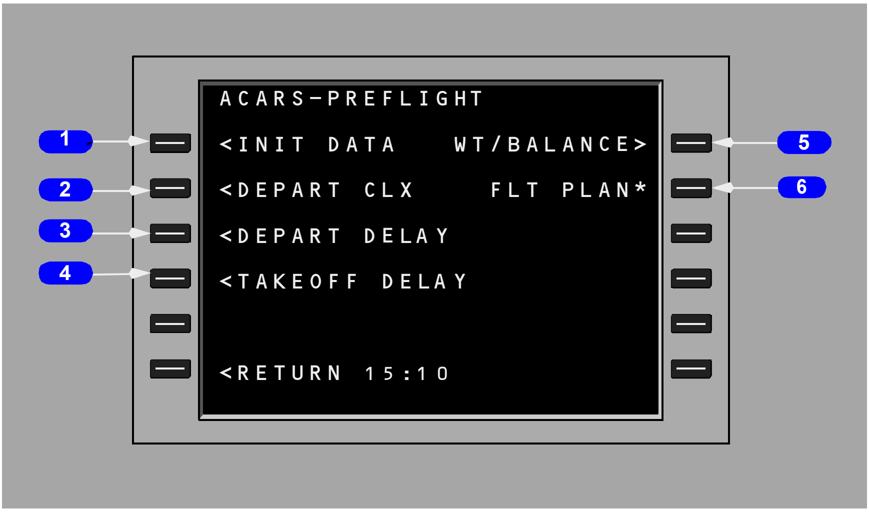
Push – selects REQUESTS page.

11 MISC MENU

Push – selects MISC MENU page.

Preflight Page

The PREFLIGHT menu page is accessible from the AOC MENU.



1 INIT DATA

Selection displays the INIT DATA page.

2 DEPART CLX

If a Departure Clearance Reports has been delivered, selection displays DEPART CLX REVIEW page; otherwise the DEPART CLX REQ page is displayed.

3 DEPART DELAY

Selection displays DEPART DELAY page.

4 TAKEOFF DELAY

Selection displays TAKEOFF DELAY page.

5 WT/BALANCE

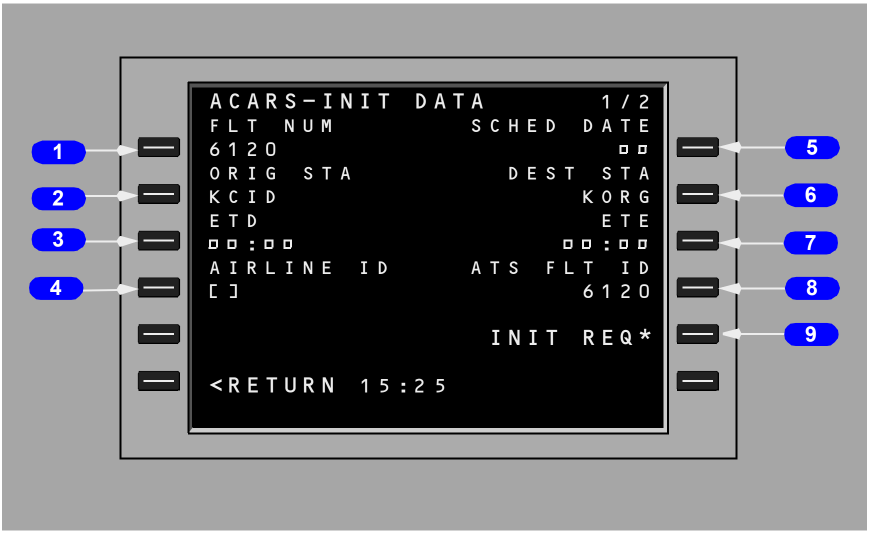
Selection displays WT/BALANCE page.

6 FLT PLAN

Selection queues the Flight Plan Request message for downlinking. The FLT PLAN time stamp displays the most recent time the Flight Plan Request message was sent this flight leg. The FLT PLAN time stamp is displayed immediately above the FLT PLAN select text.

INIT DATA Page 1/2

The INIT DATA pages allow the operator to enter/review flight initialization and/or downlink an INIT REQ message. This page is accessible from the PREFLIGHT menu and, when activated, via the INIT advisory.



1 **FLT NUM**

Flight Number: 1-4 alpha-numeric characters

2 **ORIG STA**

Flight departure station: 3-4 alpha characters.

3 **ETD**

Estimated time of departure: hhmm

4 **AIRLINE ID**

Airline identifier: 2 alpha-numeric characters.

5 **SCHED DATE**

Flight scheduled departure date: 1-2 numeric characters from 1 to 31, left zero filled.

6 **DES STA**

Flight destination station: 3-4 alpha characters.

7 ETE

Estimated flight time enroute: hhmm

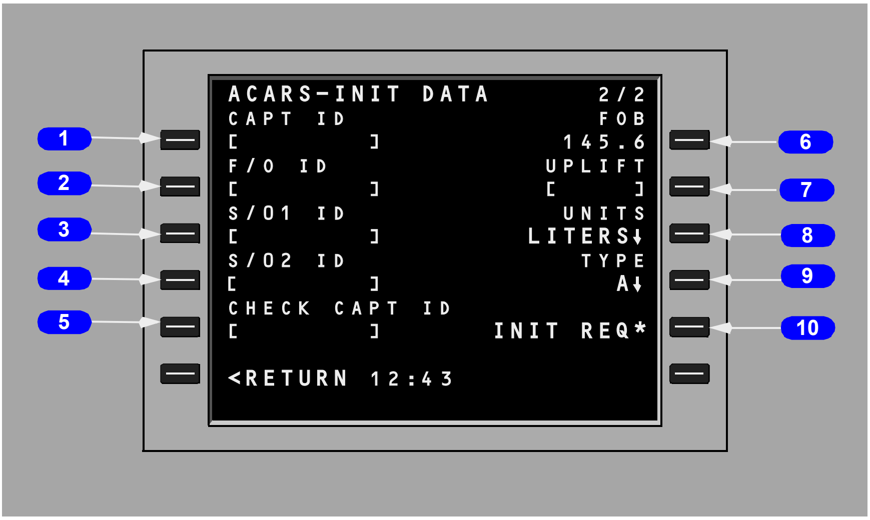
8 ATS FLT ID

ATS flight identifier: 2-7 alpha-numeric characters.

9 INIT REQ

Selecting INIT REQ key results in downloading the Automatic Initialization Request Message.

INIT DATA Page 2/2



1 CAPT ID

Captain’s identity code: 1-9 numeric characters.

2 F/O ID

First officer’s identity code: 1-9 numeric characters.

3 S/01 ID

Second officer # 1 identity code: 1-9 numeric characters.

4 S/02 ID

Second officer # 2 identity code: 1-9 numeric characters.

5 CHECK CAPT ID

Check captain's identity code: 1-9 numeric characters.

6 FOB

Current fuel on board: nnn.n 1-4 numeric characters, decimal is optional.

7 UPLIFT

Uplifted fuel quantity: 1-6 numeric characters, left-zero filled.

8 UNITS

Selection will step through the following list: LITERS, US GALS, IMP GALS.

9 TYPE

Selection will step through the following list: A, A1, B, RP, RT, TS.

10 INIT REQ

Selecting INIT REQ key results in downloading the Automatic Initialization Request Message.

DEPART DELAY Page

The DEPART DELAY page allows the operator to enter/review departure delay information and downlink a Departure Delay Report. This page is accessible form the PREFLIGHT menu, and when available, via the DEP DELAY active advisory.

1 ETD

Estimated departure time: hhmm. Manual entry only.

2 FOB

Current fuel on board: nnn.n 1-4 numeric characters, decimal is optional.

3 EST TIME OFF

Estimated takeoff time: hhmm. Shows ETO calculated as OUT time plus 20 minutes.

4 EDIT

Displays Edit Free Text page.

TAKEOFF DELAY Page

The TAKOFF DELAY page allows the operator to enter/review takeoff delay information and downlink a Takeoff Delay Report. This page is accessible from the PREFLIGHT menu, the DELAY menu and when available, via the T/O DELAY active advisory.

1 EST TIME OFF

Estimated time off: hhmm. Shows ETD calculated as OUT time plus 20 minutes.

2 FOB

Current fuel on board.

3 EDIT

Displays Edit Free Text page.

WT/BALANCE Page

The WT/BALNCE page allows the operator to enter/review weight and balance information and downlink a Weight/Balance Request message. This page is accessible from the PREFLIGHT page.

1 RUNWAY

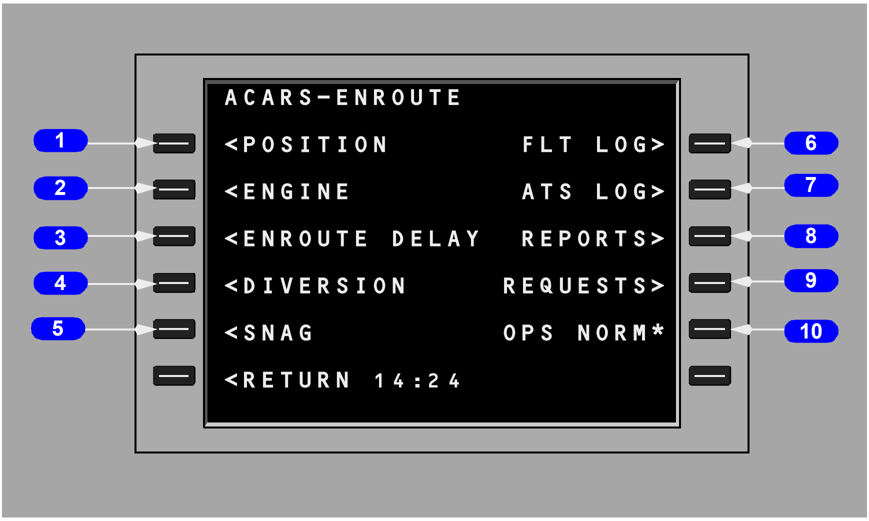
Takeoff runway number: nna. When RUNWAY has been entered SEND is displayed, and selection queues the WT/BALANCE Request message for downlinking.

2 EDIT

Displays Edit Free Text page.

ENROUTE Page

The ENROUTE page provides nine page selects and one function call. This page is accessible from the AOC MENU.



1 POSITION

Selection displays POSITION page.

2 ENGINE

Selection displays ENGINE page.

3 ENROUTE DELAY

Selection displays ENROUTE DELAY page.

4 DIVERSION

Selection displays DIVERSION page.

5 SNAG

Selection displays SNAG page.

6 FLT LOG

Selection displays the FLT LOG page.

7 ATS LOG

Selection displays ATS LOG page.

8 REPORTS

Selection displays REPORTS page.

9 REQUESTS

Selection displays REQUESTS page.

10 OPS NORM

Selection disables OPS NORM advisory and queues an Operation Normal Report for downlinking.

POSITION Page

The POSITION page provides selection of the POSITION REPORT page and a REQUEST function key. This page is accessible from the ENROUTE page.

1 MANUAL RPT

Selection displays POSITION RPT page.

2 REQUEST

Selection queues a Position Report Req message for delivery to the ACMS/DFDAU/FDAMS.

REPORTS Page 1/2

The REPORTS menu pages provide 13 page selects. This page is accessible from the ENROUTE or AOC MENU page.

1 POSITION

Selection displays the POSITION page.

2 ENGINE

Selection displays the ENGINE page.

3 DELAY

Selection displays the DELAY page.

4 DIVERSION

Selection displays the DIVERSION page.

5 SNAG

Selection displays the SNAG page.

6 OPS

Selection displays the OPS page.

7 MAINT

Selection displays the MAINT page.

8 **OTHER RPT**

Selection displays the OTHER RPT page.

9 **IN RANGE**

Selection displays the IN RANGE page.

10 **ETA**

Selection displays the ETA page.

REPORTS Page 2/2

1 **CREW**

Selection displays the CREW page.

2 **STATIONS**

Selection displays the STATIONS page.

3 **DISPATCH**

Selection displays the DISPATCH page.

CREW Page

The CREW page allows the operator to enter/review crew information and downlink a Crew Report. This page is accessible from the REPORTS page 2/2.

1 FREE TEXT

Each line is formatted to accept 1-24 characters.

2 EDIT

The EDIT FREE TEXT page allows the operator to edit/review/ accept free text. This page is accessible from the EDIT prompt.

STATIONS Page

The STATIONS page allows the operator to enter/review station information and downlink a Stations Report. This page is accessible from the REPORTS page 2/2.

1 FREE TEXT

Each line is formatted to accept 1-24 characters.

2 EDIT

The EDIT FREE TEXT page allows the operator to edit/review/ accept free text. This page is accessible from the EDIT prompt.

DISPATCH Page

The DISPATCH page allows the operator to enter/review dispatch information and downlink a Dispatch Report. This page is accessible from the REPORTS page 2/2.

1 FREE TEXT

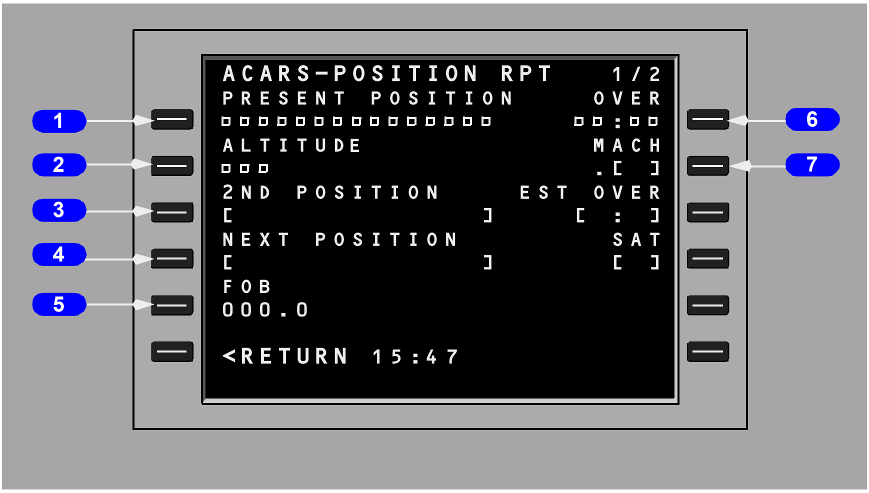
Each line is formatted to accept 1-24 characters.

2 EDIT

The EDIT FREE TEXT page allows the operator to edit/review/ accept free text. This page is accessible from the EDIT prompt.

POSITION RPT Page 1/2

The POSITION RPT pages allow the operator to enter/review position/weather information and downlink a Position/Weather Report. This page is accessible from the POSITION page.



1 PRESENT POSITION

Present position (Latitude/Longitude, Waypoint, or Navaids ID): up to 15 characters of free text.

2 ALTITUDE

Present altitude: 1-3 numeric characters.

3 2ND POSITION

First following position (latitude/longitude, waypoint, or Navaid ID): up to 15 characters of free test.

4 NEXT POSTION

Second following position (latitude/longitude, waypoint, or Navaids ID).

5 FOB

Current fuel on board.

6 OVER

Time when at PRESENT POSITION: up to 15 characters of free text.

7 **MACH**

Crossing speed at PRESENT POSITION: 1-3 numeric characters.

POSITION RPT Page 2/2

1 **WIND (DIR/VEL)**

Wind direction and speed.

2 **TURB**

Present turbulence condition. Selection will step through the following: SMOOTH, LIGHT, MODERATE, HEAVY, SEVERE.

3 **SKY COND**

Present sky condition. Selection will step through the following: CLEAR, SCATTERED, BROKEN, OVERCAST, UNDERCAST.

ENGINE Page

The ENGINE page provides a selection to the ENGINE RPT page and a function key. This page is accessible from the ENROUTE page.

1 MAN/RPT

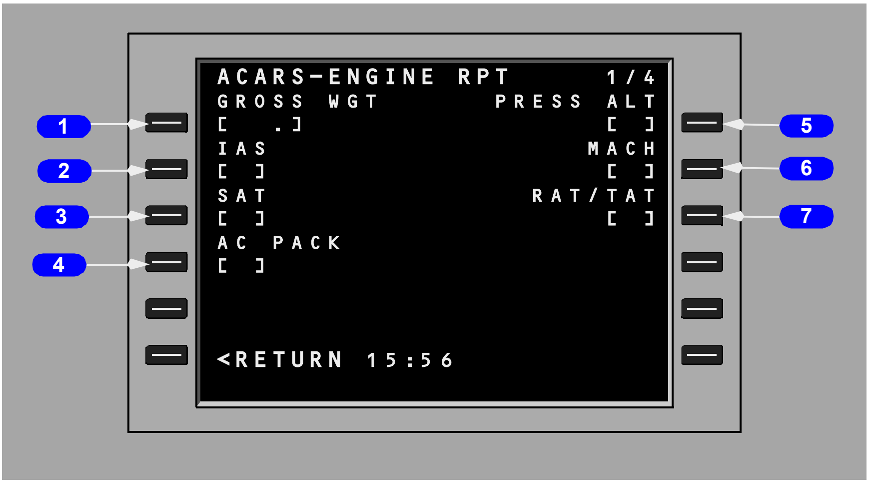
Selection displays the ENGINE RPT page.

2 REQUEST

Selection queues an Engine Report Request message for delivery to the ACMS/DFDAU/FDAMS.

ENGINE RPT Page

'The ENGINE RPT pages allow the operator to enter/review engine information and downlink the Engine Report. An engine page will be available for each engine.



1 GROSS WGT

User entry of gross weight in thousands of pounds: nnn(,)n, decimal is optional.

2 IAS

User entry of indicated air speed in knots: 1-3 numeric characters.

3 SAT

User entry of static air temp: - or + and nn.

4 AC PACK

Air conditioning pack setting: 1-3 numeric characters.

5 PRESS ALT

User entry of altitude in hundreds of feet: 1 - 3 numeric characters.

6 MACH

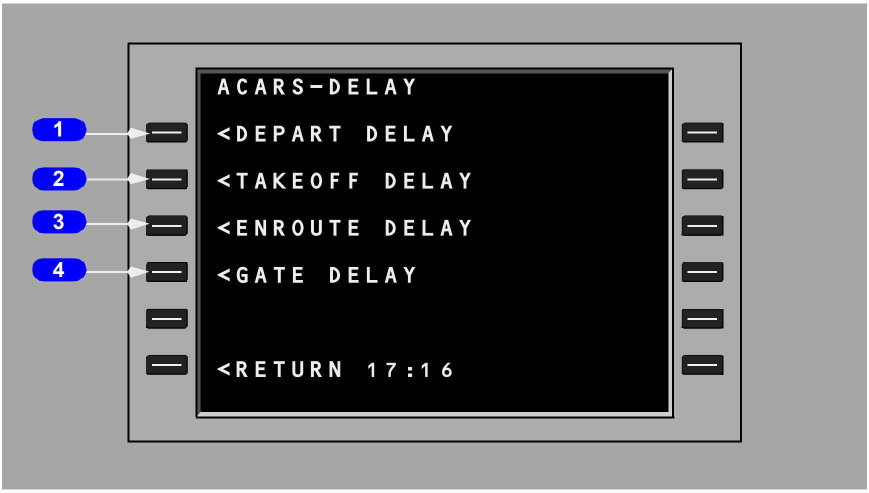
User entry of Mach value: 1-3 numeric characters.

7 RAT/TAT

User entry of Total air Temperature.

DELAY Page

The DELAY page provides four delay dependent page selects. This page is accessible from the REPORTS page 1.



1 DEPART DELAY

Selection displays the DEPART DELAY page.

2 TAKEOFF DELAY

Selection displays the TAKEOFF DELAY page.

3 ENROUTE DELAY

Selection displays the ENROUTE DELAY page.

4 GATE DELAY

Selection displays the GATE DELAY page.

ENROUTE DELAY Page

The ENROUTE DELAY page allows the operator to enter/review enroute delay information and downlink an ENROUTE DELAY message. The is page is accessible from the ENROUTE page.

1 EFC TIME

Estimated further clearance time: hhmm.

2 FOB

Current fuel on board.

3 ETA

Estimated time of arrival: hhmm.

4 EDIT

Displays Edit Free Text page.

GATE DELAY Page

The GATE DELAY page allows the operator to enter/review gate delay information and downlink a GATE DELAY message. This page is accessible from the DELAY MENU page.

1 DEST STA

Destination station: 3 or 4 alpha characters.

2 FOB

Current fuel on board.

3 ERT

Estimated ramp time: hhmm

DIVERSION Page

The DIVERSION page allows the operator to enter/review diversion information and downlink a DIVERSIN REPORT message. This page is accessible from the REPORTS MENU page.

1 DIVERTING TO

Station being diverted to: 3 or 4 alpha characters.

2 FOB

Current fuel board.

3 ETA

Estimated time of arrival.

SNAG Page

The SNAG page allows the operator to enter/review snag/discrepancy information and downlink a SNAG REPORT. Fifteen snag records are available. When all records are filled, the report must be sent. The snag records are cleared after the report is sent. Entries may be reviewed by using the NEXT PAGE and PREV PAGE selections. This page is accessible from the REPORTS MENU page.

1 FAULT CODE

Fault code in 1-8 alpha numeric characters.

2 STATUS

Aircraft status. Selection steps through the following: GO, MEET, NO GO.

OPS Page

The OPS page allows the operator to enter/review operations control information and downlink an Operations Report. This page is accessible from the REPORTS page 1/2.

1 FREE TEXT

Each line is formatted to accept 1-24 characters.

2 EDIT

The EDIT FREE TEXT page allows the operator to edit/review/ accept free text. This page is accessible from the EDIT prompt.

MAINT Page

The MAINT page allows the operator to enter/review maintenance information and downlink a Maintenance Report. This page is accessible from the REPORTS page 1/2.

1 FREE TEXT

Each line is formatted to accept 1-24 characters.

2 EDIT

The EDIT FREE TEXT page allows the operator to edit/review/ accept free text. This page is accessible from the EDIT prompt.

OTHER RPT Page

The OTHER RPT page allows the operator to enter/review information and downlink an OTHER REPORT message. This page is used to send free text message to a specific teletype (TTY) address on the ground. A second address field is provided to allow the message to be delivered to a second TTY address without the need for re-entering the text. this page is accessible from the REPORTS MENU page.

1 ADDRESS

TTY address

2 ADDRESS

Additional TTY address

3 EDIT

Displays Edit Free Text page.

IN RANGE Page

The IN RANGE page allows the operator to enter/review in range information and downlink an In Range Report. This page is accessible from the REPORTS MENU page and, when available, via the IN RANGE active advisory.

1 DEST STA

Destination station: 3-4 alpha characters.

2 ERT

Estimated ramp time: hhmm (time: hours, minutes)

3 FREE TEXT

Each line is formatted to accept 1-24 characters.

4 ETA

Estimated time of arrival: hmm (time: hours, minutes)

5 EDIT

The EDIT FREE TEXT page allows the operator to edit/review/ accept free text. This page is accessible from the EDIT prompt.

ETA Page

The ETA page allows the operator to enter/review ETA information and downlink an ETA Report. This page is accessible from the REPORTS MENU page.

1 ETA

Estimated time of arrival: hmm (time: hours, minutes)

2 FOB

Current fuel on board: 1-4 numeric characters.

3 FREE TEXT

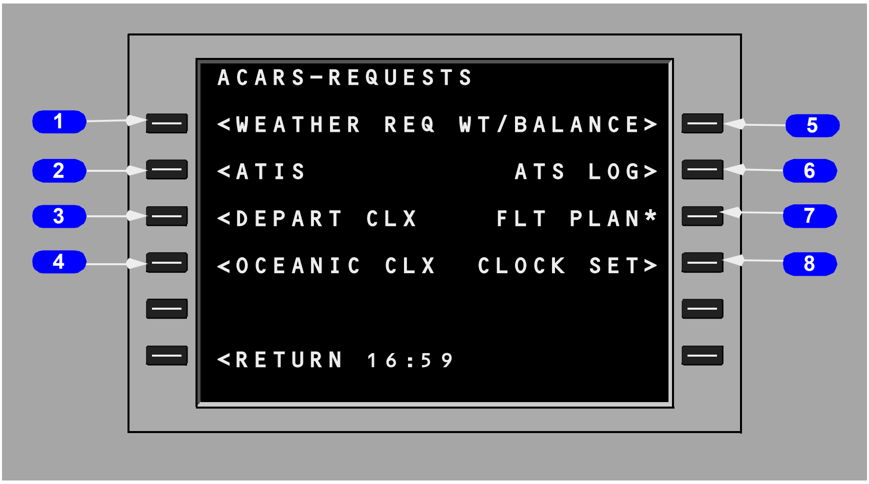
Each line is formatted to accept 1-24 characters.

4 EDIT

The EDIT FREE TEXT page allows the operator to edit/review/ accept free text. This page is accessible from the EDIT prompt.

REQUESTS Page

The REQUESTS page provides seven page selects and one function call. This page is accessible from the AOC MENU page.



1 WEATHER REQ

Selection displays the WEATHER REQ page.

2 ATIS

Selection displays the ATIS page.

3 DEPART CLX

If a Departure Clearance Report has been delivered, selection displays DEPART CLX REVIEW page; otherwise, the DEPART CLX REQ page is displayed.

4 OCEANIC CLX

If an OCEANIC Clearance Report has been delivered, selection displays OCEANIC CLX REVIEW page; otherwise, the OCEANIC CLX REQ page is displayed.

5 WT/BALANCE

Selection displays the WT/BALANCE page.

6 ATS LOG

Selection displays the ATS LOG page.

7 FLT PLAN

Selection queues the Flight Plan Request message for downlinking.

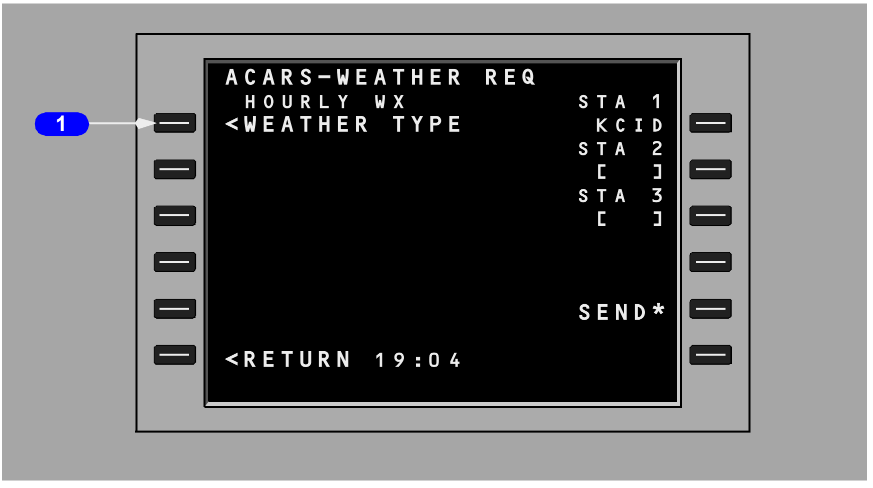
8 CLOCK SET

This page is part of the technical application.

WEATHER REQ Page

The WEATHER REQ page allows the operator to enter/review weather information and downlink a Weather Request message. This page is accessible from the REQUESTS menu.

This page is not cleared after sending, allowing the operator to check the chosen weather periodically without having to reenter the desired stations.

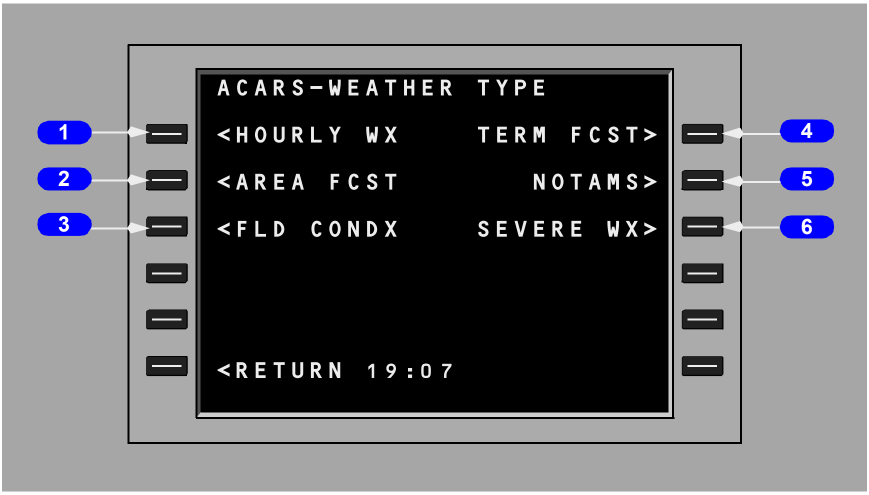


1 WEATHER TYPE

Selection displays the WEATHER TYPE page. Hourly weather is automatically loaded at the beginning of a flight leg.

WEATHER TYPE Page

The WEATHER TYPE page allows the operator to select the type of weather used on the WEATHER REQ page. This page is accessible from the WEATHER REQ page. Selection of any item on this page displays the WEATHER REQ page with the chosen weather shown above the WEATHER TYPE field.



1 HOURLY WX

Selection displays the WEATHER REQ page with HOURLY WX shown in the TYPE field.

2 AREA FCST

Selection displays WEATHER REQ page with AREA FCST shown in the TYPE field.

3 FLD CONDX

Selection displays the WEATHER REQ page with FLD CONDX shown in the TYPE field.

4 TERM FCST

Selection displays the WEATHER REQ page with TERM FCST shown in the TYPE field.

5 NOTAMS

Selection displays the WEATHER REQ page with NOTAM shown in the TYPE field.

6 **SEVERE WX**

Selection displays the WEATHER REQ page with SEVERE WX shown in the TYPE field.

POSTFLIGHT Page

The POSTFLIGHT page provides six pages selects. This page is accessible from the AOC MENU page.

1 **FLT SUMMARY**

Selection displays the FLT SUMMARY page.

2 **FLT LOG**

Selection displays the FLT LOG page.

3 **ATS LOG**

Selection displays the ATS LOG page.

4 **REPORTS**

Selection displays the REPORTS page.

5 **REQUESTS**

Selection displays the REQUESTS page.

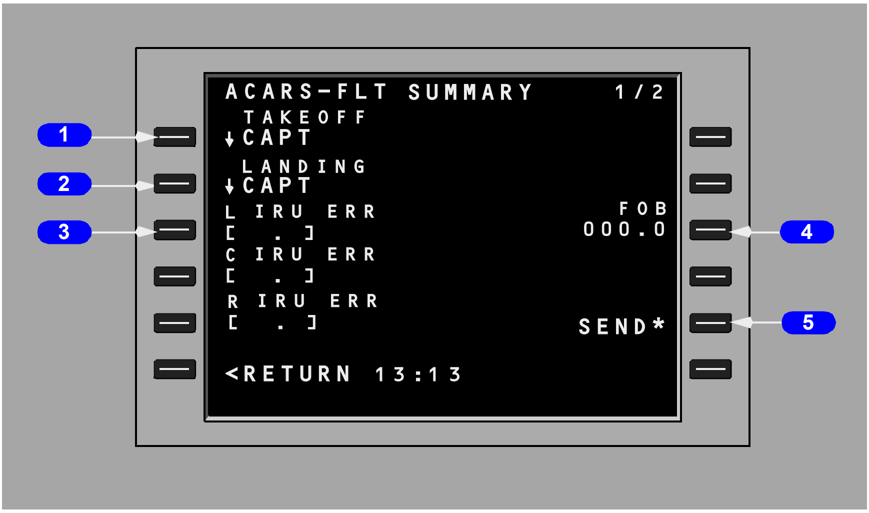
6 **MISC MENU**

Selection displays the MISC MENU page.

FLT SUMMARY Page

The FLT SUMMARY page allows the operator to enter/review flight summary information and downlink a Flight Summary Report. This page is accessible from the POSTFLIGHT MENU page and, when available, via the SUMMARY active advisory.

The Flight Summary Report is downlinked automatically if the SEND select is available and the page is exited without selecting the SEND key



1 TAKEOFF

Takeoff pilot: selection steps through the following list: “CAPT”, “F.O.”, “OTHER”.

2 LANDING

Landing pilot: selection steps through the following list: “CAPT”, “F.O.”, “OTHER”.

3 X IRU ERR

Left, center or right IRU error: 1-3 numeric characters.

4 FOB

Current fuel on board: 1-4 numeric characters.

5 SEND

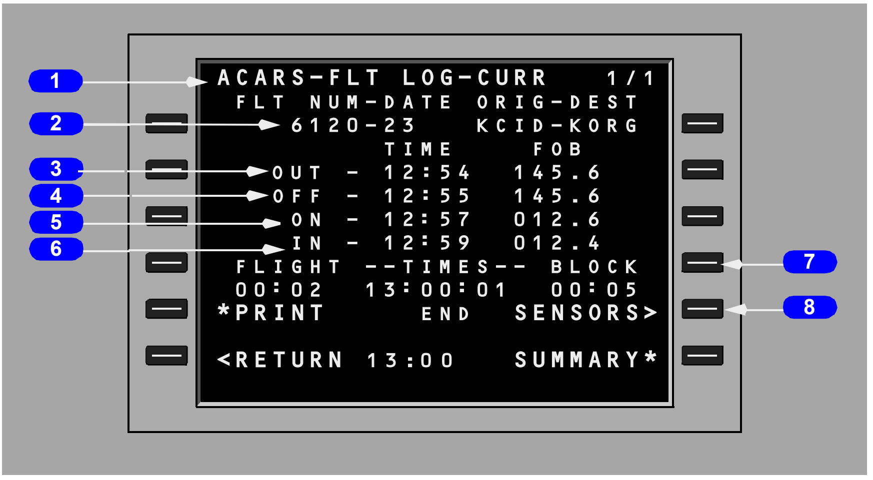
Select becomes available only if all required fields are filled, both pages have been

viewed, the system is in the END LEG state, and either the Flight Summary Report has never been sent or some data has been altered.

FLT LOG Page

Selection allows the user to review OOOI information for the current and up to four previous flight legs. The current/previous flight leg information is reset at the end of flight leg event. This page is accessible from the AOC MENU page.

Any field for which information has not yet been collected is filled using spaces. Any field for which information was not available is filled using dashes.



1 FLT LOG-CURR or PREV

Status of record being displayed. CURR if page 1 and PREV if pages 2-5.

2 FLT NUM-DATE

Flight number and scheduled departure date.

3 OUT TIME, FOB

Out event time and fuel on board at out event.

4 OFF TIME, FOB

Off event time and fuel on board at off event.

5 ON TIME, FOB

On event time and fuel on board at on event.

6 IN TIME, FOB

In event time and fuel on board at in event.

7 BLOCK TIME

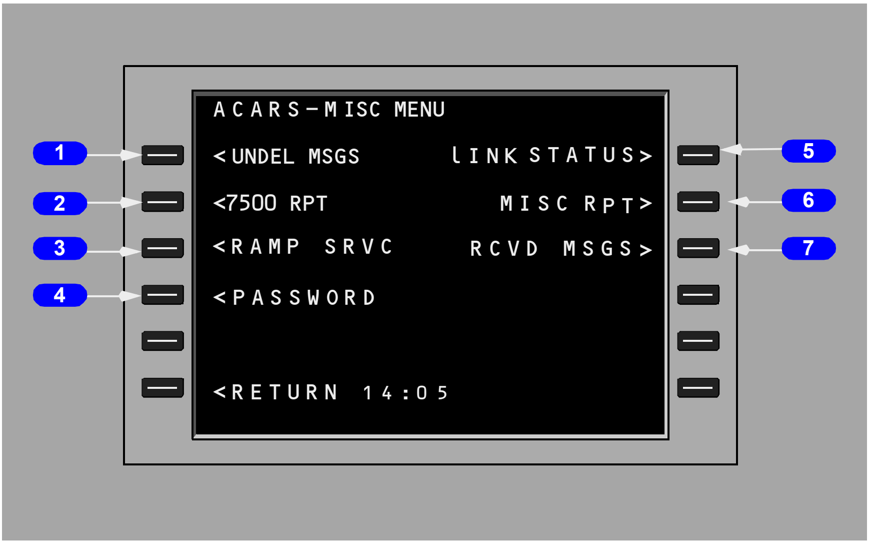
Total block time, IN TIME minus OUT TIME.

8 SENSORS

Selection displays the OOOI SENSORS page.

ACARS MISC MENU Page

The MISC MENU page provides seven page selects. This page is accessible from the POSTFLIGHT MENU page.



1 UNDEL MSGS

Selection displays the UNDEL MSGS page.

2 7500 RPT

Selection displays the 7500 RPT page.

3 RAMP SRVC

Selection displays the RAMP SRVC page.

4 PASSWORD

Selection displays the PASSWORD page.

5 **LINK STATUS**

Selection displays the LINK STATUS page. This page is part of the technical application.

6 **MISC RPT**

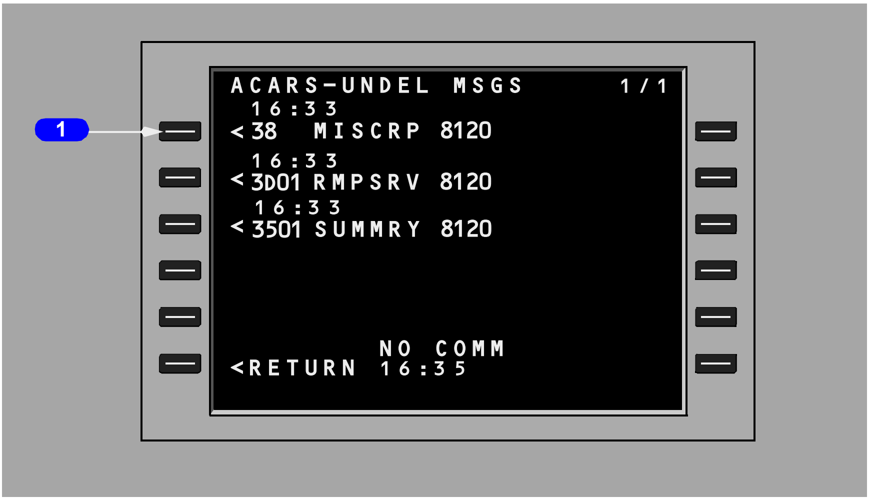
Selection displays the MISC RPT page.

7 **RCVD MSGS**

Selection displays the RCVD MSGS page.

UNDEL MSGS Page

The UNDEL MSGS menu page allows the operator to review all undelivered messages for which an acknowledgment from the ground has not been received, and select an individual message for viewing. This page is accessible from the MISC MENU page.



1 **Undelivered Messages — (UNDEL MSGS)**

Selection displays the undelivered message.

7500 RPT Page

The 7500 RPT page allows the operator to enter/review information about an emergency situation and downlink an Emergency report message. This page is accessible from the MISC MENU page.

1 **FREE TEXT**

Displays free text lines.

2 **ELAM**

Number of males: 1-2 numeric characters.

3 **PAEW**

Are weapons being used? Selection toggles between “YES” and “NO”.

4 **TPCNI**

Are they in the cockpit? Selection toggles between “NO” and “YES”.

5 **MEF**

Number of females: 1-2 numeric characters.

6 **PMET**

What is temperament? Selection will step through the following list: “U”nknown, “C”alm, “I”ntense.

7 **SEND**

Select is always available. Selection queues message for downlinking.

RAMP SRVC Page

RAMP SRVC page allows the operator to enter/review all ramp service information and downlink a ramp Service Report. This page is accessible from the MISC MENU page.

1 **LAV SRVC**

Is lavatory service required? Selection will steo through “NO” and “YES”.

2 **MEDIC**

Is paramedical service required? Selection will step through “NO” and “YES”.

3 **WHEEL CHR**

Number of wheel chair required.

4 **MEET/ASST**

Is meet/assist service required? Selection will step through “NO” and “YES”.

5 **CABIN SRVC**

Is cabin service required? Selection will step through “NO and “YES”.

6 **SECURITY**

Is security service required? Selection will step through “NO” and “YES”.

7 **UNACC MINOR**

Number of unaccompanied minors on board.

PASSWORD Page

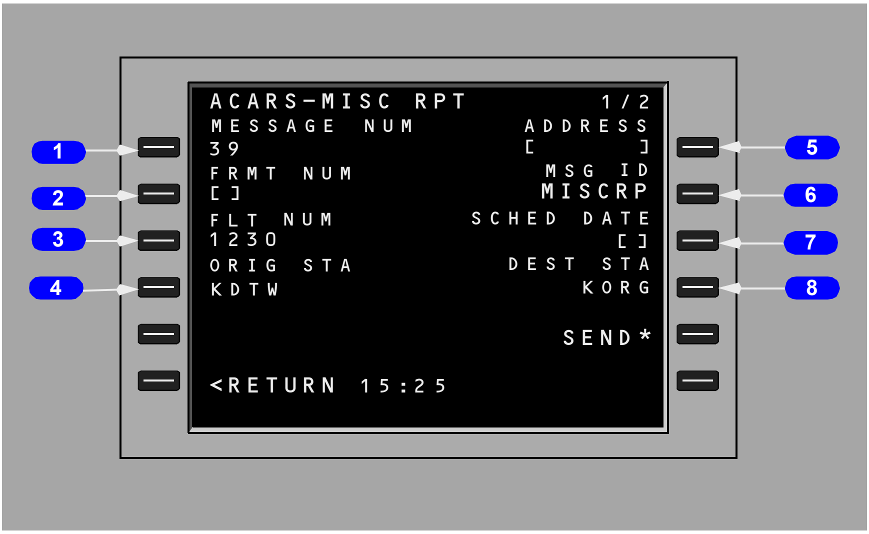
The PASSWORD page allows the operator to enter the password providing access to protected AOC application functions. Functions are protected when operational performance is dependent on the function. This page is assessable from the MISC MENU.

1 **PASSWORD**

Selection compares the scratchpad data with the password. If the password is matched, the PARAMETERS page is displayed. If the password is not matched, the text, “INVALID” is displayed on the page.

MISC RPT Page

MISC RPT allows the operator to enter/review miscellaneous information and downlink a Misc Report message. This page is accessible from the MISC MENU page.



1 MESSAGE NUM

Message Number: 1-2 numeric characters. Default value is 39.

2 FRMT NUM

Message Format number: 1-2 numeric characters.

3 FLT NUM

Flight number: 1-6 alpha-numeric characters.

4 ORIG STA

Origination station: 3-4 alpha characters.

5 ADDRESS

Additional TTY address: 7 alpha-numeric characters.

6 MSG ID

Message identifier: 1-6 alpha-numeric characters. Default value is “MISCRP”.

7 **SCHED DATE**

Flight scheduled departure date: 1-2 numeric characters from 1 to 31, left zero filled.

8 **DES STA**

Flight destination station: 3-4 alpha characters.

RCVD MSGS MENU Page

The RCVD MSGS menu page allows the operator to review all uplink display messages and select an individual message for viewing. This page is accessible from the MISC MENU page.

1 **Message Title**

Displays the message title.

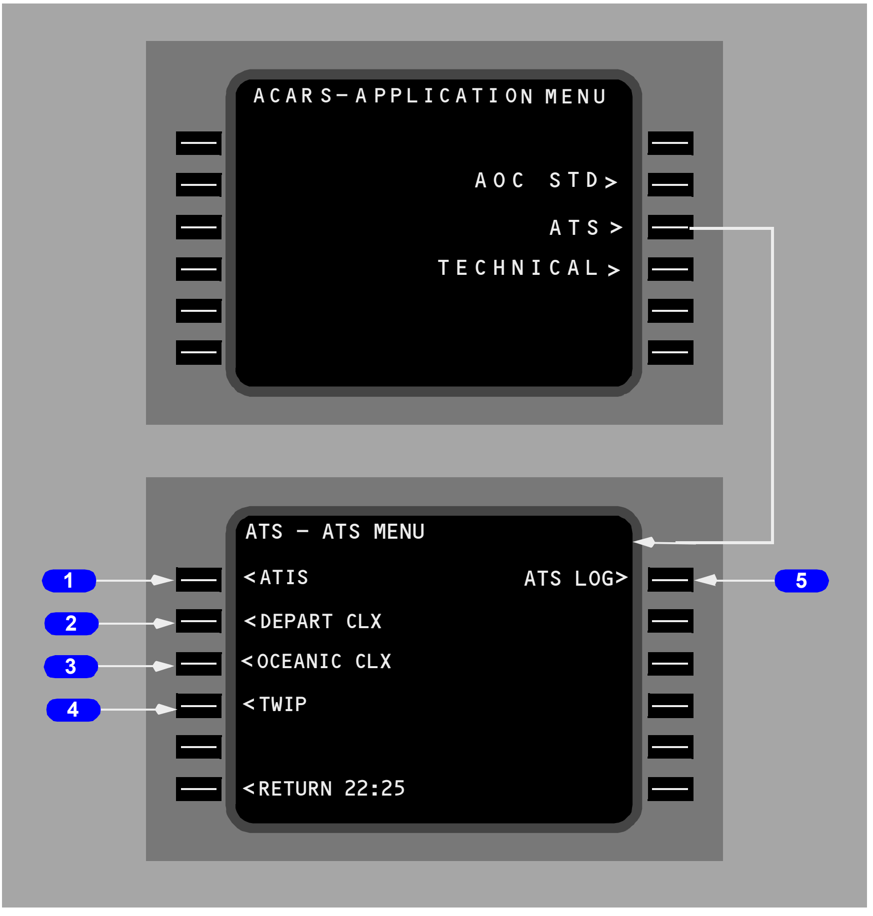
2 **Message Status**

Displays the message status.

- NEW — Message has not been viewed.
- ACKED — Message has been acknowledged when required.
- VIEWED — Message has been viewed.

Air Traffic Services – (ATS) page

The ATS MENU page provides access to the Air Traffic Services pages. This page is accessible from the Application Menu display.



1 ATIS

Selection displays the ATIS page.

2 DEPART CLX

If a Departure Clearance Report has been delivered, selection displays the DEPART CLX REVIEW page; otherwise, the DEPART CLX REQ page is displayed.

3 **OCEANIC CLX**

If an OCEANIC Clearance Report has been delivered, selection displays the OCEANIC CLX REVIEW page; otherwise, the OCEANIC CLX REQ page is displayed.

4 **TWIP RQ**

If a Terminal Weather Information for Pilots Report has been delivered, selection displays the TWIP REVIEW page, otherwise, the TWIP RQ page ia displayed.

5 **ATS LOG**

Selection displays the ATS LOG page.

ATIS Request – (ATIS RQ)

The ATIS RQ page allows the operator to send an ATIS Request message. This page is accessible from ATS MENU page if an ATIS Report has not been received. If an ATIS Report has been received, then this page is accessible from the ATIS REVIEW page. Note that not all airports support digital ATIS. In some cases, where digital ATIS is not supported, there is no uplink response to the downlink request.

1 **AIRPORT**

Airport of interest: 3–4 alpha numeric characters.

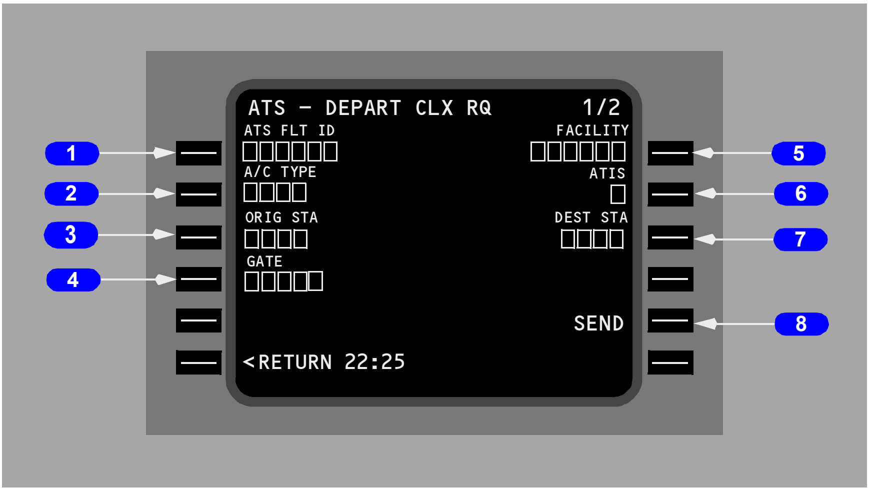
2 **SERVICE TYPE**

ATIS report type. Selection steps through the following list: DEPARTURE ATIS, ENROUTE INFO SERVICE, ARRIVAL ATIS.

Departure Clearance Request – (DEPART CLX RQ)

The DEPARTURE CLX RQ page allows the operator to send a Departure Clearance Request message. This page is accessible from the ATS MENU, the DEPART CLX REVIEW page, and the AOC – PREFLIGHT MENU page.

Default data may be available for all fields except FREE TEXT. Default data is updated on this page whenever it changes.



1 ATS FLT ID

ATS flight identifier. Default flight ID may be provided: 2–7 alpha numeric characters.

2 AC TYPE

Aircraft type. Default data may be available.

3 ORIG STA

Departure airport. Four character ICAO airport code. Default data may be available.

4 GATE

Current gate position of the aircraft: 1–5 alpha numeric characters.

5 FACILITY

Teletype address of ATC facility servicing predeparture clearance request or four character ICAO airport code. Default data may be available.

6 **ATIS**

Current received ATIS information designation.

7 **DEST STA**

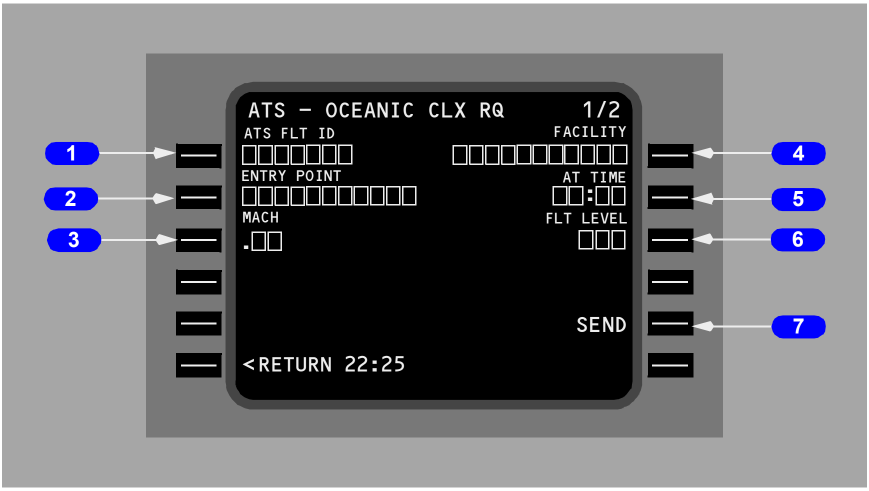
Destination airport.

8 **SEND**

Selection available only if all required fields are filled. Downlinks the operator supplied data for the requested report or message.

OCEANIC Clearance Request – (OCEANIC CLX RQ)

The OCEANIC CLX RQ page allows the operator to send an Oceanic Clearance Request message. This page is accessible from the ATS MENU and the OCEANIC CLX REVIEW page.



1 **ATS FLT ID**

ATS flight identifier. A default flight ID may be available. Format: 2 – 7 alpha-numeric characters.

2 **ENTRY POINT**

Oceanic track entry point identifier. Latitude/ Longitude value is checked for validity. Format: 4 – 11 alpha-numeric characters. Latitude/Longitude: (N or S) + Lat (1, 2 or 4 numeric) + (E or W) + Long (1, 2, 3, or 5 numeric) or Lat (1, 2 or 4 numeric) + (N or S) + Long (1, 2, 3, or 5 numeric) + (E or W).

The Latitude must be less than 90 degrees. The longitude must be less than 180 degrees. Named Reporting Point: Navaid ID/Waypoint: 3 – 5 alpha characters.

3 MACH

Mach number requested for cruise. Format: two numeric characters.

4 FACILITY

Oceanic clearance facility. Selection will step through the following list: GANDER, REYKJAVIK, SANTA MARIA, SHANWICK.

5 AT TIME

Estimated time of arrival at entry fix. Format: hh:mm (time: hours, minutes).

6 FLIGHT LEVEL

Altitude requested at entry fix. Format: 1 – 3 numeric characters.

7 SEND

Selection available only if all required fields are filled. Downlinks the operator supplied data for the requested report or message.

Terminal Weather Information for Pilots Request – (TWIP RQ)

The TWIP RQ page allows the operator to send a TWIP (Terminal Weather Information for Pilots) Request message. This page is accessible from the ATS MENU or the TWIP REVIEW page.

The auto update TWIP request message will inform the ground service provider that TWIP reports should be delivered to the airplane as they are updated. Selecting/sending the START AUTO–UPDATES reporting mode starts the automatic updates. Selecting/sending the STOP AUTO–UPDATES reporting mode terminates the automatic updates. Not all airport support the automatic update features.

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1 AIRPORT

Departure station before the OFF event. Destination station after the OFF event.

2 REPORTING MODE

Selection will step through the following list: SINGLE REPORT, START AUTO–UPDATES, STOP AUTO UPDATES.

3 PRESENTATION

Request text or graphics presentation of TWIP report. Selection will toggle between TEXT and GRAPHICS.

4 SEND

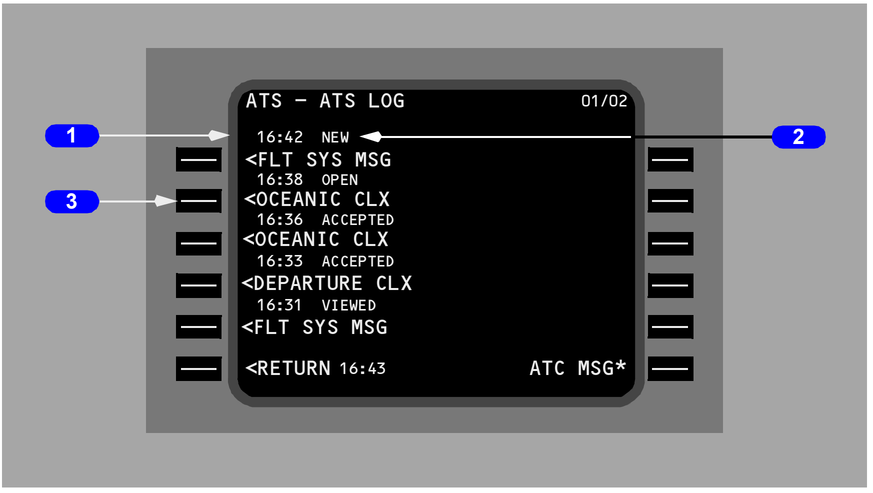
Selection available only if all required fields are filled. Downlinks the operator supplied data for the requested report or message.

Air Traffic Services Log Page – (ATS LOG)

The ATS LOG page allows the operator to view a list of uplinked Departure Clearance, Oceanic Clearance, and Flight System messages, and select an individual message for viewing. This page is accessible from the ATS MENU and the AOC MENU page.

Up to 25 message titles can be listed on these pages.

The messages on this page are purged on transition to the start of a new flight.



1 Time Stamp

UTC time when message was received.

2 View Status

Departure or OCEANIC Clearance Report messages:

UPLINK MESSAGE STATUS	DESCRIPTION
NEW	Clearance has not been viewed.
OPEN	At least one page of the clearance has been displayed.
VIEWED	All pages of the clearance have been displayed.
ACCEPTED	Clearance has been accepted.

Flight System Messages:

UPLINK MESSAGE STATUS	DESCRIPTION
NEW	Message has not been viewed.
OPEN	At least one page of the message has been displayed.
VIEWED	All pages of the message have been displayed.

3 Message Title

The message title will default to the first 16 characters of the uplink message if any unknown labels or message format errors are found.

- DEPART CLX – Departure Clearance report.
- OCEANIC CLX – Oceanic Clearance Report.
- FLT SYS MSG – Flight System Message.

Intentionally
Blank

Air Traffic Control Data Link

For airplanes with the Air Traffic Control (ATC) data link function installed, these functions are accomplished on the CDU. They include Air Traffic Services (ATS) Facilities Notification, Automatic Dependent Surveillance (ADS), Aeronautical Telecommunication Network (ATN) and ATC Data Link.

The ATC LOGON/STATUS page provides the capability to initiate an Air Traffic Services Facilities Notification (AFN), downlink to a specified ATS facility and to display the ADS, ATC DL, and data link status.

The ATC UPLINK pages display messages uplinked by an ATS facility and provide the capability to respond to uplinked messages and to load clearances which contain loadable data.

The ATC REQUEST pages provide capability to create downlink requests for vertical and speed clearances, lateral offsets, and route changes.

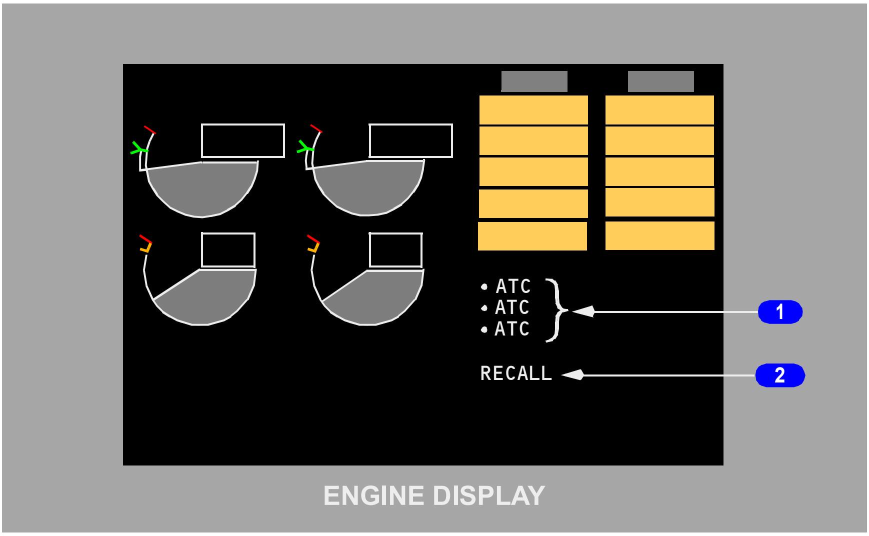
The FMC formats reports in response to requests from an ATS facility for reports and confirmation. These reports are accessible via the ATC REPORT page and display for review or modification on the VERIFY REPORT pages.

The ATC LOG page provides a list of all uplinks and downlinks stored in the ATC Log and provides access to the XXXXZ ATC UPLINK, XXXXZ ATC REQUEST, XXXXZ ATC REPORT, and XXXXZ EMERGENCY pages corresponding to each logged uplink or downlink.

To accomplish Automatic Dependent Surveillance, the FMC can simultaneously receive requests from five ATC centers and one airline center. Airline ADS addresses are stored in the airline policy file. The ADS functions include periodic, event, and on–demand reporting. The type and content of a report is initiated by uplink request. These functions are automatic. The flight crew can disable this function on the ATC LOGON/STATUS page.

ATC Uplink Message

An uplinked ATC message will be accompanied by a white •ATC message on the primary engine display and a Hi/Lo chime over the flight deck loudspeaker. ATC MESSAGE will also be displayed in the CDU scratch pad.



1 •ATC Uplink Message (white)

Indicates receipt of an uplinked ATC message. Hi/Lo chime is sounded and ATC MESSAGE is displayed on the CDU scratch pad.

The •ATC message will continue to be displayed as long as any pending ATC uplink messages remain in the queue.

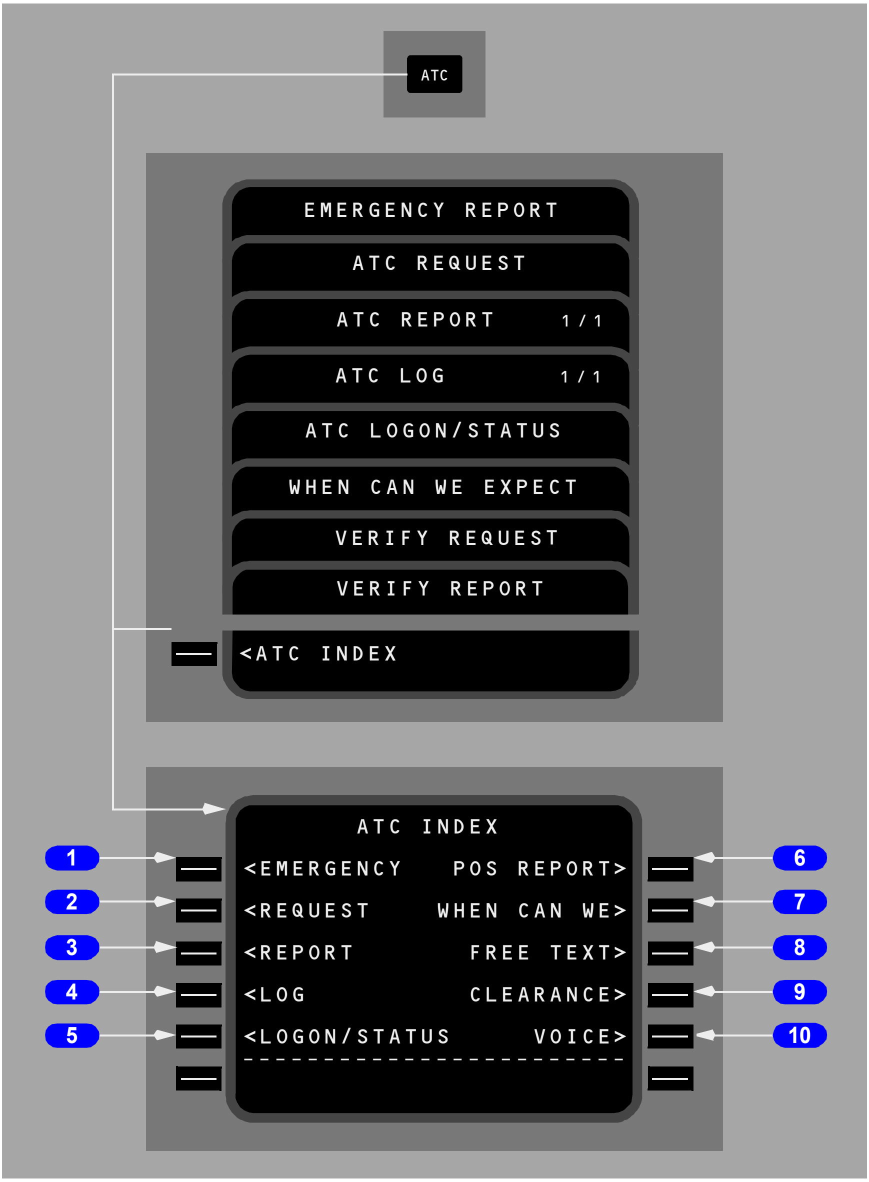
2 •RECALL (white)

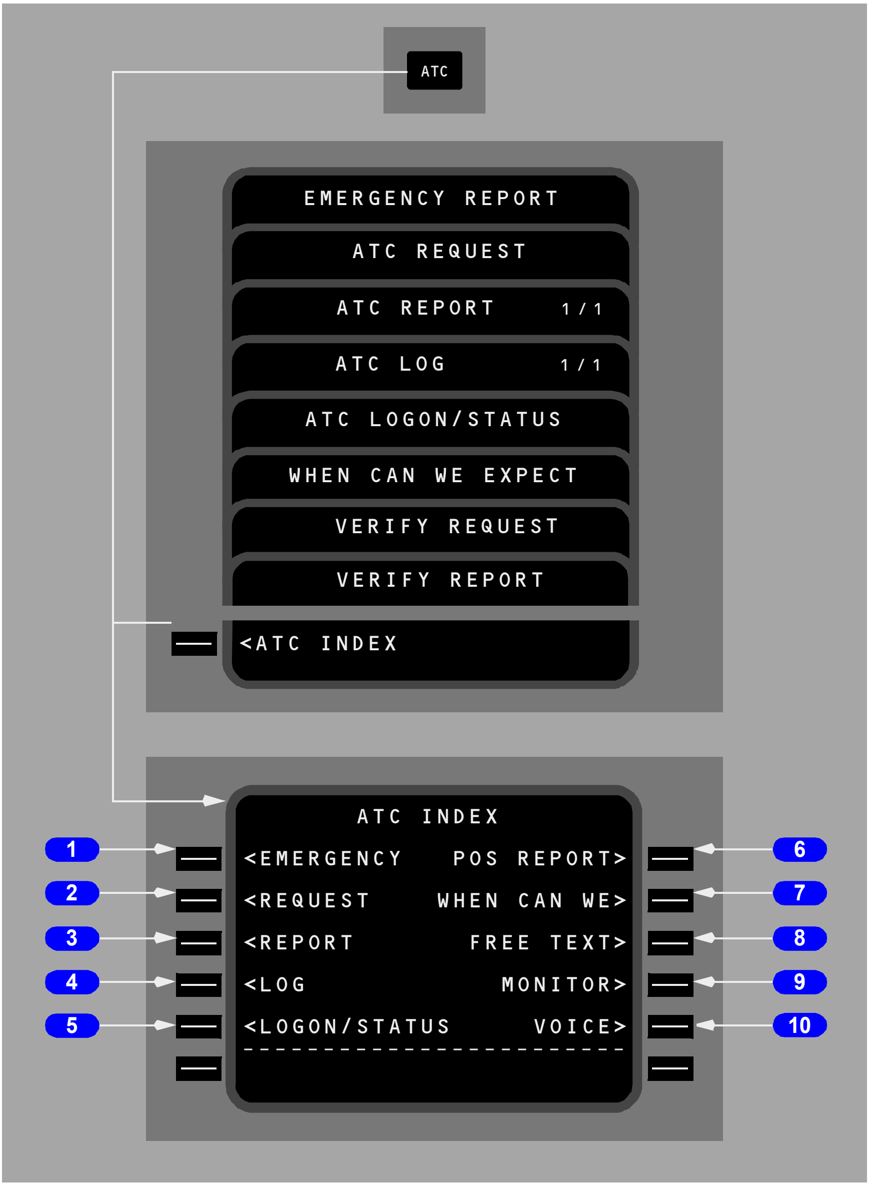
Recalls Communication messages.

ATC Index Page

The ATC INDEX CDU page provides access to pages used for ATC data link functions.

Note: For those FANS pages that do not exist in the ATN environment, upon inter-center transfer from a FANS Center to an ATN Center these pages revert to the ATC INDEX page.


ATC
EMERGENCY REPORT
ATC REQUEST
ATC REPORT 1/1
ATC LOG 1/1
ATC LOGON/STATUS
WHEN CAN WE EXPECT
VERIFY REQUEST
VERIFY REPORT
<ATC INDEX
ATC INDEX
<EMERGENCY
POS REPORT>
<REQUEST
WHEN CAN WE>
<REPORT
FREE TEXT>
<LOG
CLEARANCE>
<LOGON/STATUS
VOICE>
1
2
3
4
5
6
7
8
9
10


ATC
EMERGENCY REPORT
ATC REQUEST
ATC REPORT 1/1
ATC LOG 1/1
ATC LOGON/STATUS
WHEN CAN WE EXPECT
VERIFY REQUEST
VERIFY REPORT
<ATC INDEX
ATC INDEX
<EMERGENCY POS REPORT>
<REQUEST WHEN CAN WE>
<REPORT FREE TEXT>
<LOG MONITOR>
<LOGON/STATUS VOICE>
1
2
3
4
5
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7
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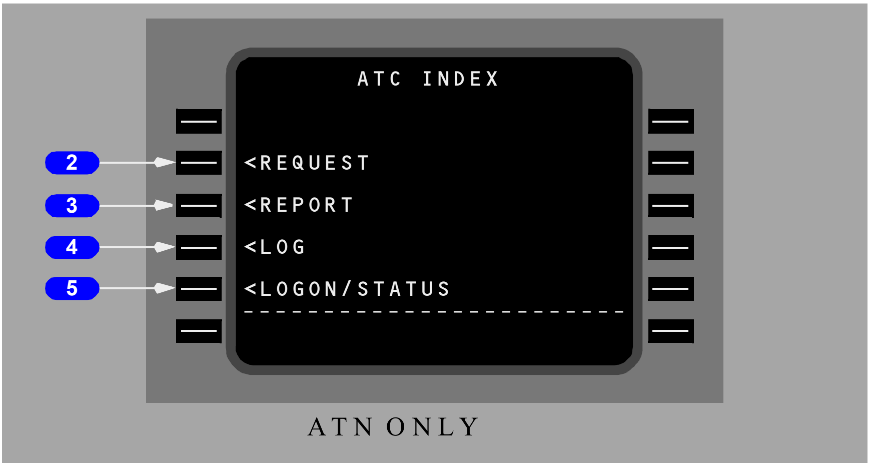
9
10



1 EMERGENCY

Push – displays EMERGENCY REPORT page.

2 REQUEST

Push – displays ATC REQUEST page.

3 REPORT

Push – displays ATC REPORT page.

4 LOG

Push – displays ATC LOG page.

5 LOGON/STATUS

Push – displays ATC LOGON/STATUS page.

6 Position Report (POS REPORT)

Push – displays POS REPORT page.

7 WHEN CAN WE

Push – displays WHEN CAN WE EXPECT page.

8 FREE TEXT

Push – displays VERIFY REPORT page for free text messages.

9 CLEARANCE

Push – displays VERIFY REQUEST pages for clearance request.

9 **MONITOR**

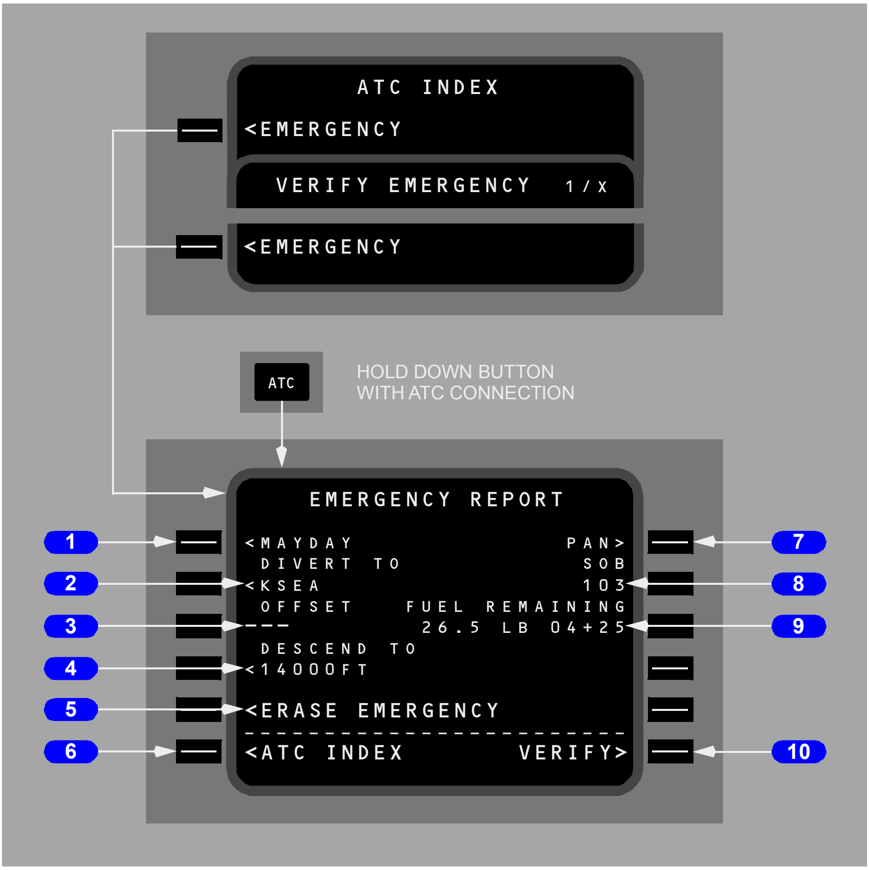
Push – displays page for all CONDITIONAL CLEARANCE uplinks that are being monitored by the system.

10 **VOICE**

Push – displays VERIFY REQUEST page for voice contact request.

Emergency Report Page

The EMERGENCY REPORT pages provide the capability to create downlink messages to alert an ATS facility to an aircraft emergency and to the lateral and vertical maneuvers the flight crew intend to execute.



1 MAYDAY

Push –

- displays VERIFY EMERGENCY page
- displays MAYDAY MAYDAY MAYDAY message
- when current altitude more than 150 feet above altitude in 4L, displays DESCENDING TO altitude on VERIFY EMERGENCY page.

2 DIVERT TO

Displays active destination airport.

Valid entries are: waypoint, navaid, airport, latitude–longitude, or place bearing/distance.

Entered position may be deleted.

Push –

- message includes remainder of route if active destination airport or enroute waypoint displayed
- message includes direct to routing if neither active destination airport or enroute waypoint are displayed.

3 **OFFSET**

Valid entry is LXX, RXX or XX (XX is any number from 1 to 99 nm.). For either side, L or R is not entered.

Message includes entered offset.

Entered offset may be deleted.

4 **DESCEND TO**

Displays MCP altitude.

Valid entry is XXX or FLXXX (flight level), XXXXX (feet), or XXXXXm (meters).

Entered altitude may be deleted.

Push – message indicates crew intention to descend to displayed altitude.

5 **ERASE EMERGENCY, CANCEL EMERGENCY**

Initial display is blank.

Entry or selection of data on any line displays ERASE EMERGENCY.

Displays CANCEL EMERGENCY after EMERGENCY REPORT sent.

ERASE EMERGENCY –

Push – erases all emergency data.

CANCEL EMERGENCY –

Push – selects CANCEL EMERGENCY message.

6 **ATC INDEX**

Push – displays ATC INDEX page.

7 **PAN**

Push –

- displays VERIFY EMERGENCY page
- displays PAN PAN PAN message.

8 **Souls On Board (SOB)**

Valid entry is number of persons on airplane.

Message includes SOB.

Entered SOB may be deleted.

9 **FUEL REMAINING**

Initial display is blank.

Displays FMC computed fuel remaining in quantity and time when a SOB number is entered.

Valid entry is HH+MM (hours and minutes).

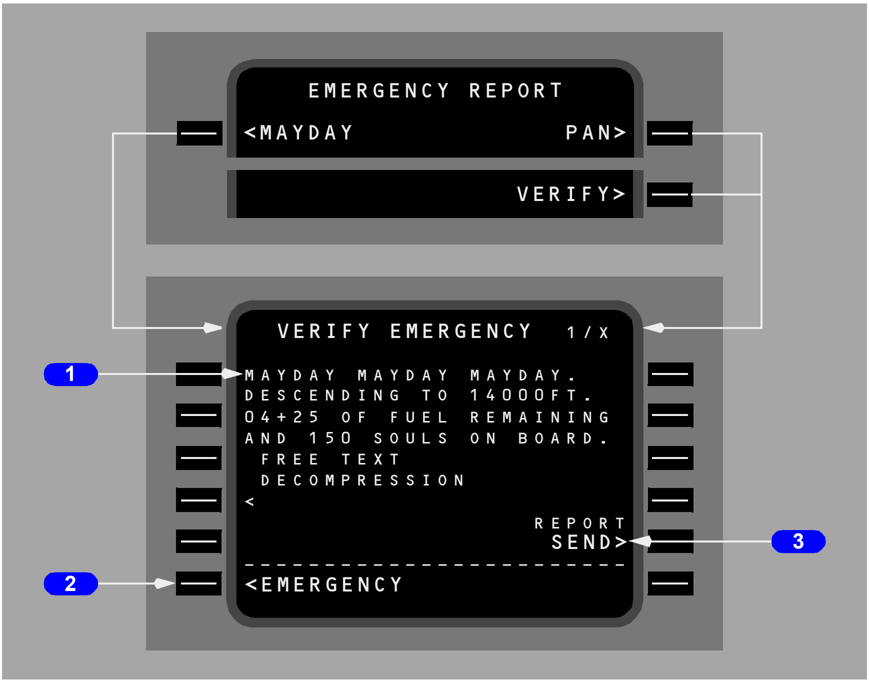
Only fuel remaining in hours and minutes is downlinked.

10 **VERIFY**

Push – displays VERIFY EMERGENCY page.

Verify Emergency Page 1/X

The VERIFY EMERGENCY page displays the EMERGENCY REPORT for review before it is sent. The page allows entering a free text message.



1 Lines 1 – 5

Page 1/X line 1 displays MAYDAY MAYDAY MAYDAY message or PAN PAN PAN message as selected on EMERGENCY REPORT page.

Pages 1/X to X/X display data from the EMERGENCY REPORT page and provide at least one line for free text entry.

2 EMERGENCY

Push – displays EMERGENCY REPORT page.

3 REPORT SEND

If the emergency message spans multiple pages, the REPORT SEND prompt will only appear on the last VERIFY EMERGENCY page.

Push –

- creates emergency report message containing information on VERIFY EMERGENCY page
- when MAYDAY selected, transmits POSITION REPORT and activates ADS in emergency mode.
- creates log entry of transmitted message.

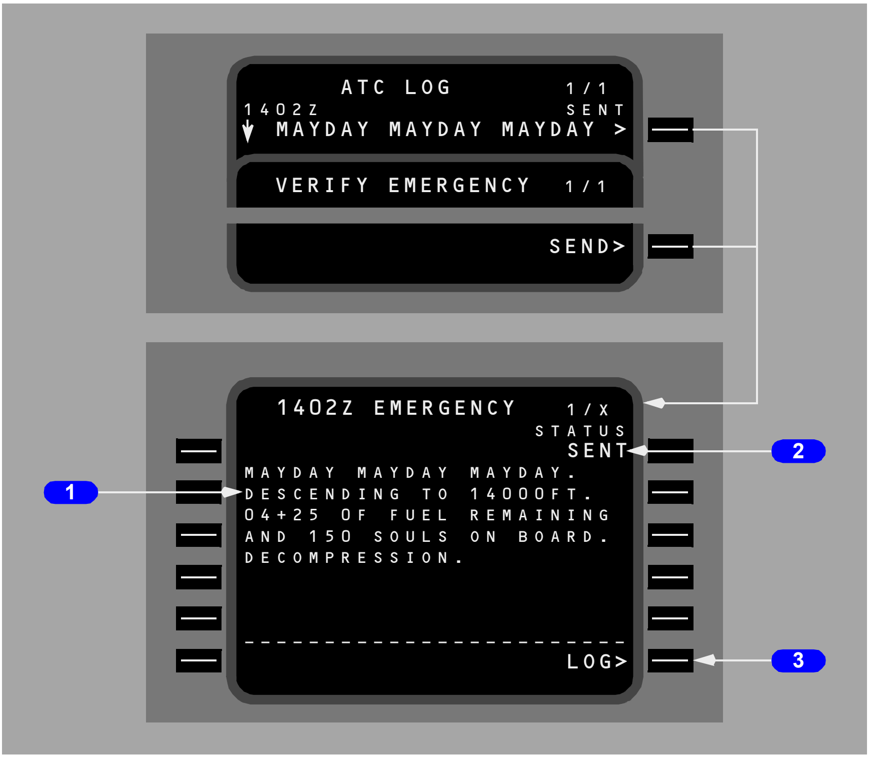
When CANCEL EMERGENCY displayed in 5L on EMERGENCY REPORT page:

Push –

- sends CANCEL EMERGENCY message
- deactivates ADS emergency mode
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays XXXXZ ATC REQUEST page upon network acknowledgement
- displays NO ATC COMM when data link READY and no ATC connection
- displays NO COMM for no available communications media.

XXXXZ Emergency Page X/X

XXXXZ EMERGENCY page displays the transmitted report. XXXXZ is the time the report was transmitted.



1 **Lines 1 – 5**

Pages 1/X to X/X display message transmitted to ATC at time of page title. Line 1 is blank on page 1/X.

2 **STATUS SENT**

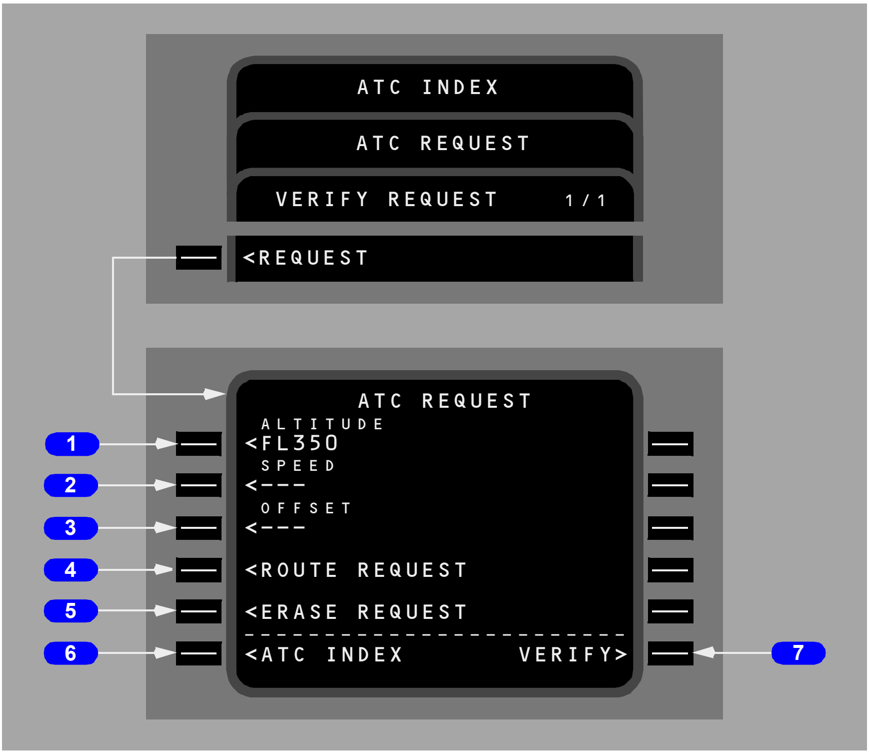
Displays emergency report status from ATC LOG page.

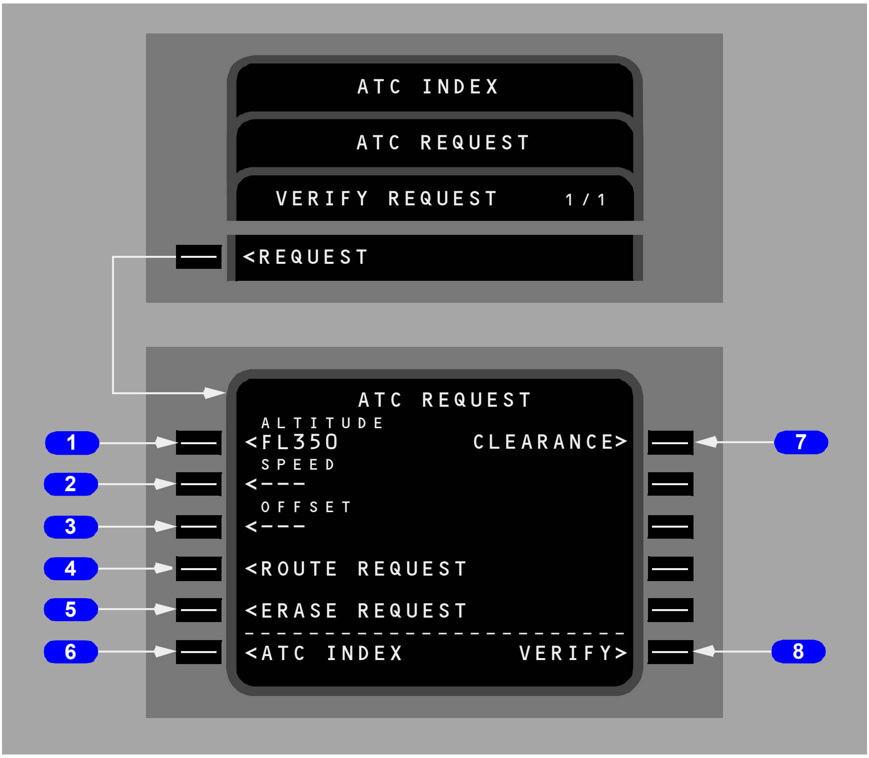
3 **LOG**

Push – Displays the ATC LOG page.

ATC Request Page

The ATC REQUEST page allows entry of altitude, speed, and offset direction and distance requests.





ATN ONLY

1 ALTITUDE

Initially displays dashes.

Valid entries are XXX or FLXXX (flight level), XXXXX (feet), XXXXXM (meters), XXXXX/XXXXX or FLXXX/FLXXX (block altitude).

Block altitude in meters is not permitted.

Entry may be deleted.

Push –

- with altitude/flight level entered, displays ATC ALT REQUEST page with altitude/flight level on altitude line
- with dashes displayed, displays ATC ALT REQUEST page with dashes on altitude line.

2 SPEED

Initially displays dashes.

Valid entry is IAS or Mach.

Entry may be deleted.

Push –

- with speed/Mach entered, displays ATC SPEED REQUEST page with speed/Mach on speed line
- with dashes displayed, displays ATC SPEED REQUEST page with dashes on speed line.

3 OFFSET

Initially displays dashes.

Valid entry is LXX, RXX or XX (XX is any number from 1 to 99 nm.). For either side, L or R is not entered.

Entry may be deleted.

Push –

- with offset entered, displays ATC OFFSET REQUEST page with offset on offset line
- with dashes displayed, displays ATC OFFSET REQUEST page with dashes on offset line.

4 ROUTE REQUEST

Push – displays ATC ROUTE REQUEST page.

5 ERASE REQUEST

Push – erases all entered or selected data on any of the four ATC REQUEST pages.

6 ATC INDEX

Push – displays ATC INDEX page.

7 VERIFY

Push – displays VERIFY REQUEST page.

7 CLEARANCE

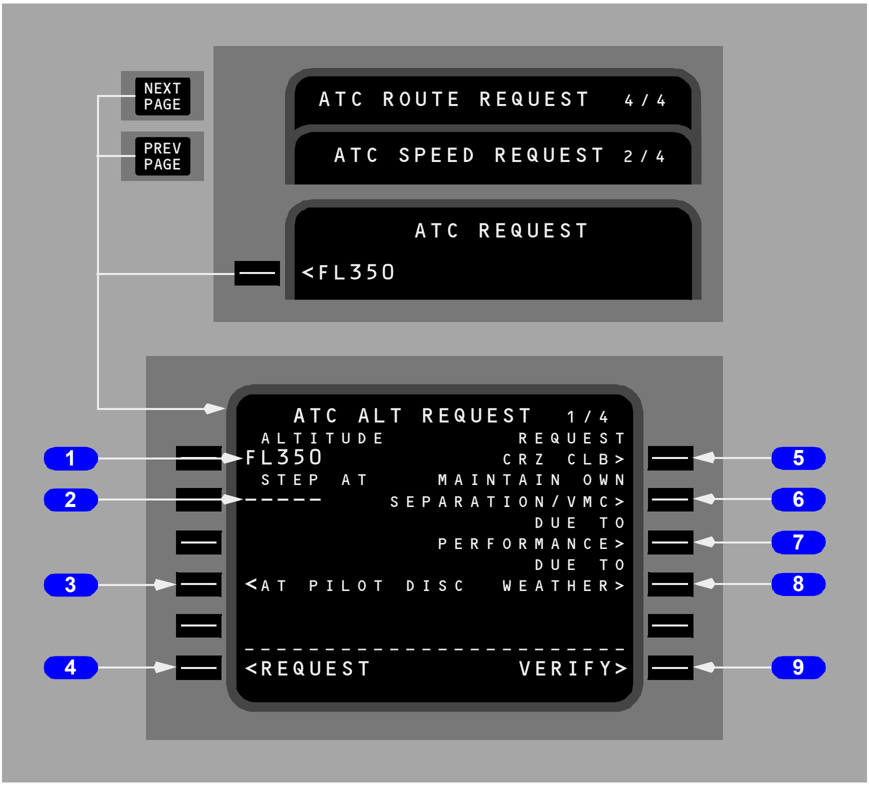
Push – results in the display of the VERIFY REQUEST page 1/X for the CLEARANCE request.

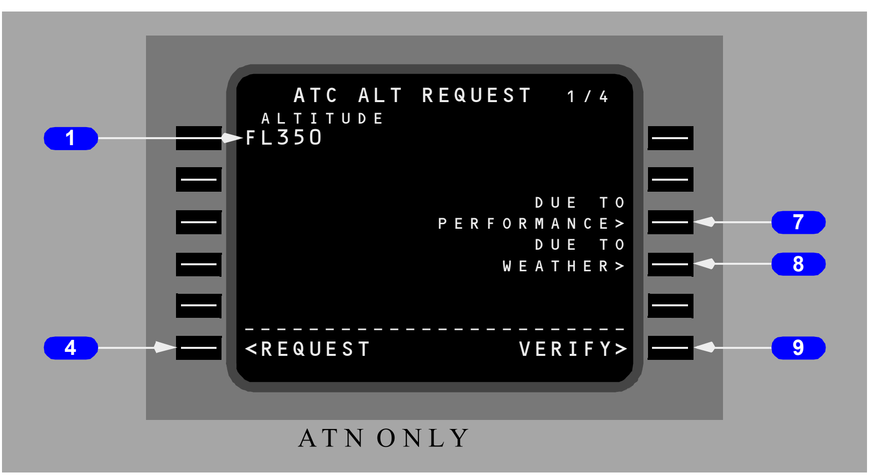
8 VERIFY

Push – displays VERIFY REQUEST page.

ATC Altitude Request Page 1/4

The ATC ALT REQUEST page 1/4 allows downlink requests for altitude changes.





1 ALTITUDE

Initially displays dashes or altitude entered on ATC REQUEST page.

Valid entries are XXX or FLXXX (flight level), XXXXX (feet), XXXXXM (meters), XXXXX/XXXXX or FLXXX/FLXXX (block altitude).

Block altitude in meters is not permitted.

Entry selects a message requesting a level altitude, climb, or descent based on current altitude.

Altitude may be deleted.

2 STEP AT

Initially displays dashes.

Valid entries are: fix name, navaid, airport, latitude–longitude, place bearing/distance, or time.

Entry of a position or time with an altitude request selects a message requesting a step up or down at a specified time based on current altitude.

Entry may be deleted.

3 AT PILOT Discretion (AT PILOT DISC)

Push – displays AT PILOT DISCRETION in large font and selects as message element.

Selection may be deleted.

4 REQUEST

Push – displays ATC REQUEST page.

5 Request Cruise Climb (REQUEST CRZ CLB)

Push – displays CRZ CLB in large font and selects message requesting cruise climb to entered altitude.

Selection may be deleted.

6 MAINTAIN OWN SEPARATION/VMC

Push – displays SEPARATION/VMC in large font and selects MAINTAIN OWN SEPARATION AND VMC message element.

Selection may be deleted.

7 DUE TO PERFORMANCE

Push – displays PERFORMANCE in large font and selects DUE TO PERFORMANCE message element.

Selection may be deleted.

8 DUE TO WEATHER

Push – displays WEATHER in large font and selects DUE TO WEATHER message element.

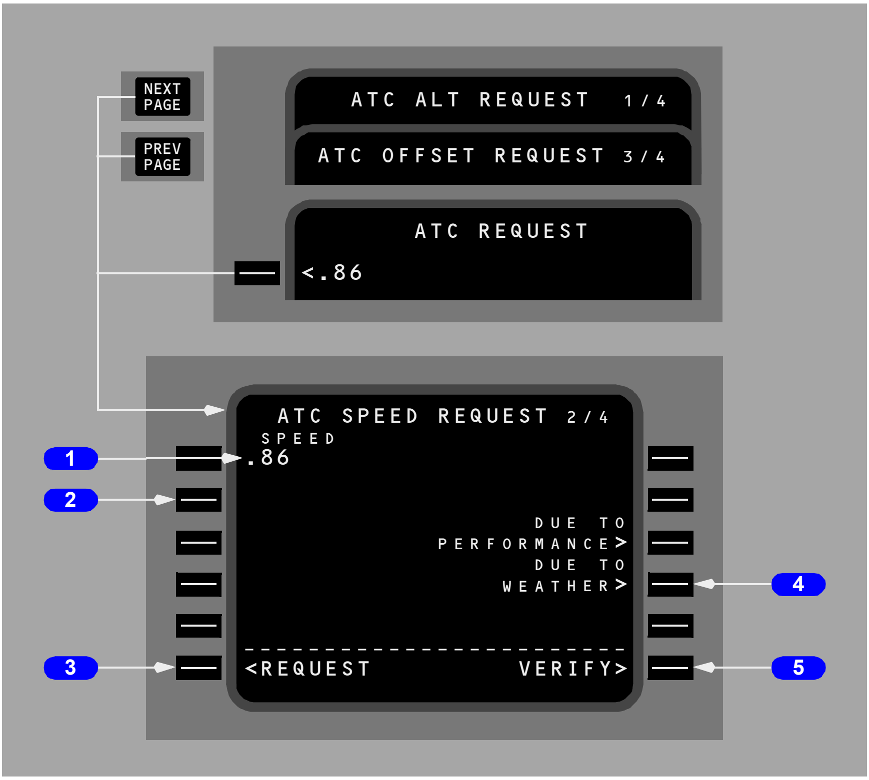
Selection may be deleted.

9 VERIFY

Push – displays VERIFY REQUEST page.

ATC Speed Request Page 2/4

The ATC SPEED REQUEST page 2/4 allows downlink requests for speed changes.



1 SPEED

Initially displays dashes or speed/Mach entered on ATC REQUEST page.

Valid entry is IAS or Mach.

Entry selects a message requesting the speed or Mach.

Entry may be deleted.

2 REQUEST

Push – displays ATC REQUEST page.

3 DUE TO PERFORMANCE

Push – displays PERFORMANCE in large font and selects DUE TO PERFORMANCE message element.

Selection may be deleted.

4 DUE TO WEATHER

Push – displays WEATHER in large font and selects DUE TO WEATHER message element.

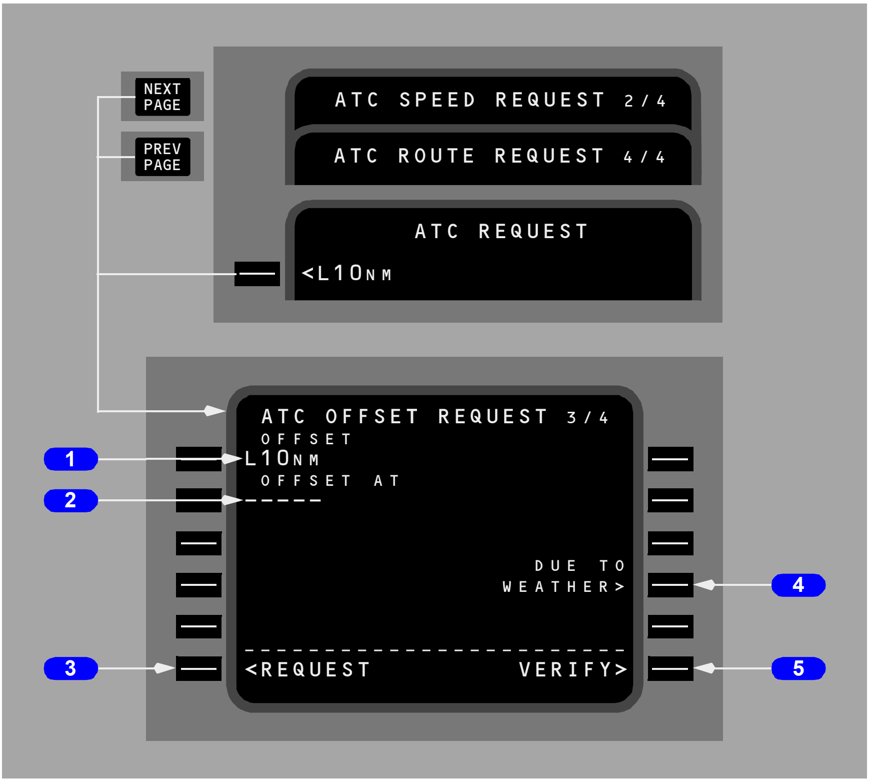
Selection may be deleted.

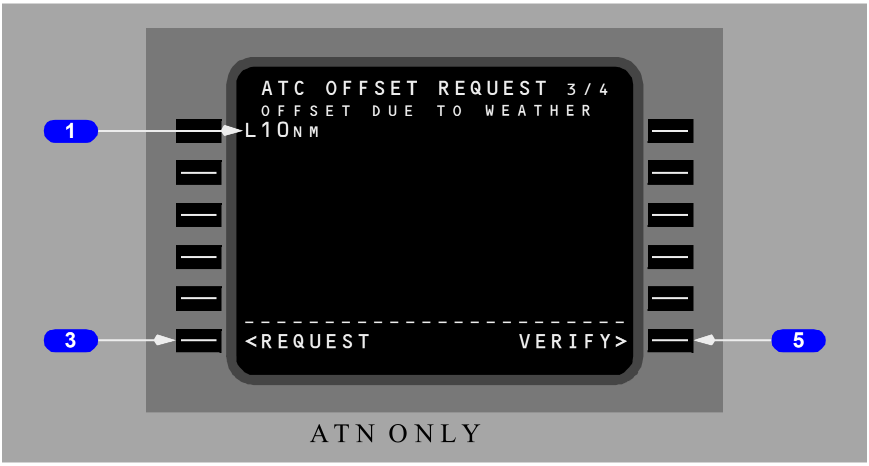
5 VERIFY

Push – displays VERIFY REQUEST page.

ATC Offset Request Page 3/4

The ATC OFFSET REQUEST page 3/4 allows downlink requests for later offsets.





1 OFFSET

Initially displays dashes or offset requested on ATC REQUEST page.

Valid entry is LXX, RXX or XX (XX is any number from 1 to 99 nm.).

Entry selects a message requesting an offset from the active route.

Entry may be deleted.

2 OFFSET AT

Entry of a position or time with an offset request selects a message requesting an offset at the specified position or time.

Valid entries are: fix name, navaid, airport, latitude–longitude, place bearing/distance, or time.

Entry may be deleted.

3 REQUEST

Push – displays ATC REQUEST page.

4 DUE TO WEATHER

Push – displays WEATHER in large font and selects REQUEST WEATHER DEVIATION UP TO entered offset direction and distance.

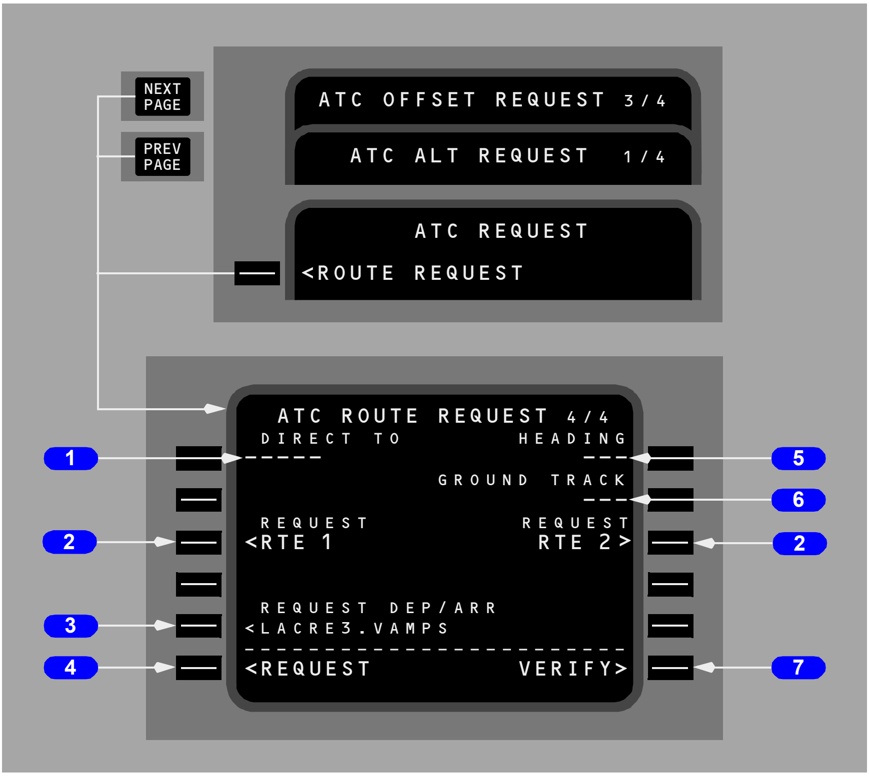
Selection may be deleted.

5 VERIFY

Push – displays VERIFY REQUEST page.

ATC Route Request Page 4/4

The ATC ROUTE REQUEST page 4/4 allows downlink requests for route changes.



ATN ONLY

1 DIRECT TO

Entry selects a message requesting a clearance direct to the position.

Valid entries are: fix name, navaid, airport, latitude–longitude, or place bearing/distance.

Entry may be deleted.

2 Route 1 or 2 REQUEST (REQUEST RTE 1 or 2)

Push – selects route stored in RTE 1 or 2 for route request. When RTE 1 or 2 has a pending modification, the modified route is requested.

Selection may be deleted.

3 Request Departure/Arrival/Transition (REQUEST DEP/ARR)

Initially displays dashes or selections made on DEP/ARR page.

Valid entry is departure or arrival (6 alpha-numeric characters max).

Valid entry is departure or arrival and transition (up to 6 alpha-numeric characters for the procedure, followed by a period, followed by up to 5 alpha-numeric characters for the transition).

A route to be searched for an origin or destination airport will be selected in the following order:

- Pending modified or pending active route
- Active route
- Inactive route 1
- Inactive route 2

Entry may be deleted.

Push – displays selected entry in large font and selects a message element requesting the selected entry.

4 REQUEST

Push – displays ATC REQUEST page.

5 HEADING

Entry selects a message requesting the specified heading.

Valid entry is XXX (heading).

Entry may be deleted.

6 GROUND TRACK

Entry selects a message requesting the specified ground track.

Valid entry is XXX (ground track).

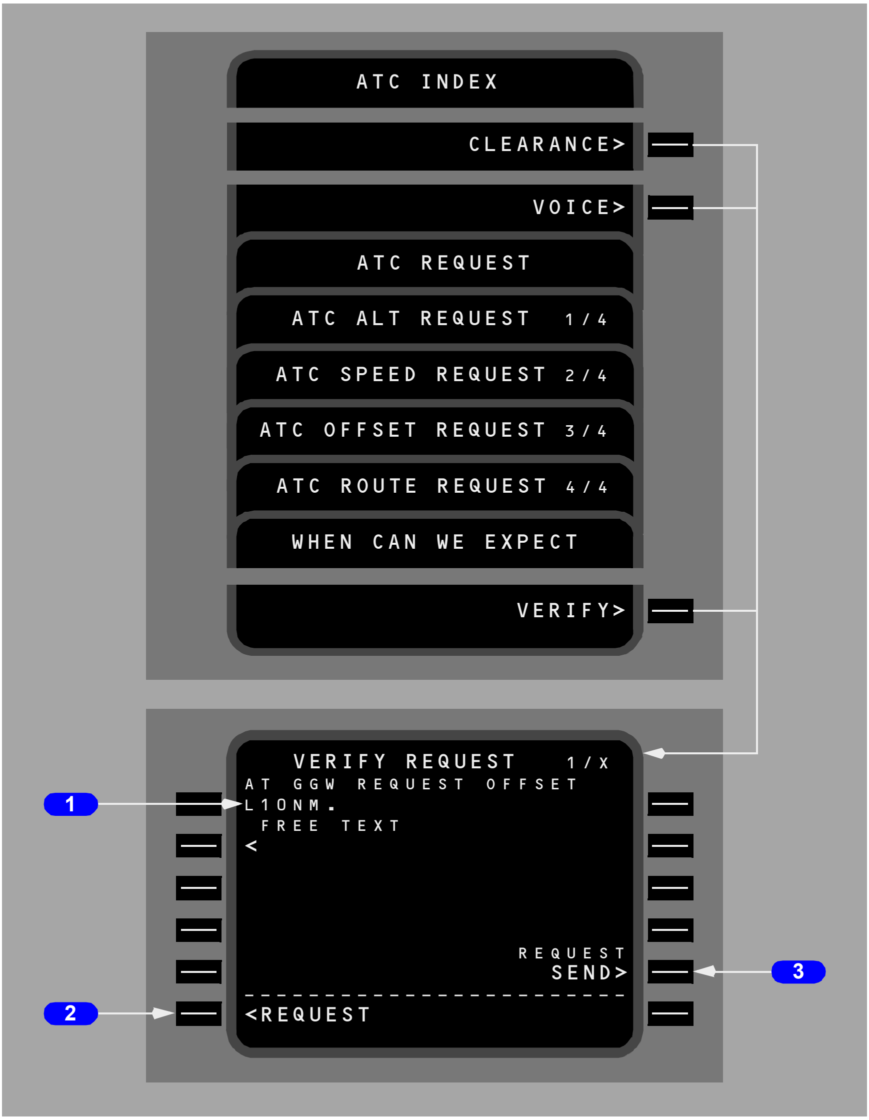
Entry may be deleted.

7 VERIFY

Push – displays VERIFY REQUEST page.

Verify Request Page X/X

The VERIFY REQUEST pages display the request for review before it is sent.



1 Lines 1 – 5

Pages 1/X to X/X display data which reflect the request and provide at least one line for free text entry.

Any entered free text included in downlink request.

2 ATC INDEX, REQUEST, WHEN CAN WE

Displays ATC INDEX when page accessed from ATC INDEX page.

Displays REQUEST when page accessed from ATC REQUEST page.

Displays WHEN CAN WE when page accessed from WHEN CAN WE EXPECT page.

REQUEST –

Push – displays ATC REQUEST page.

ATC INDEX –

Push – displays ATC INDEX page.

WHEN CAN WE –

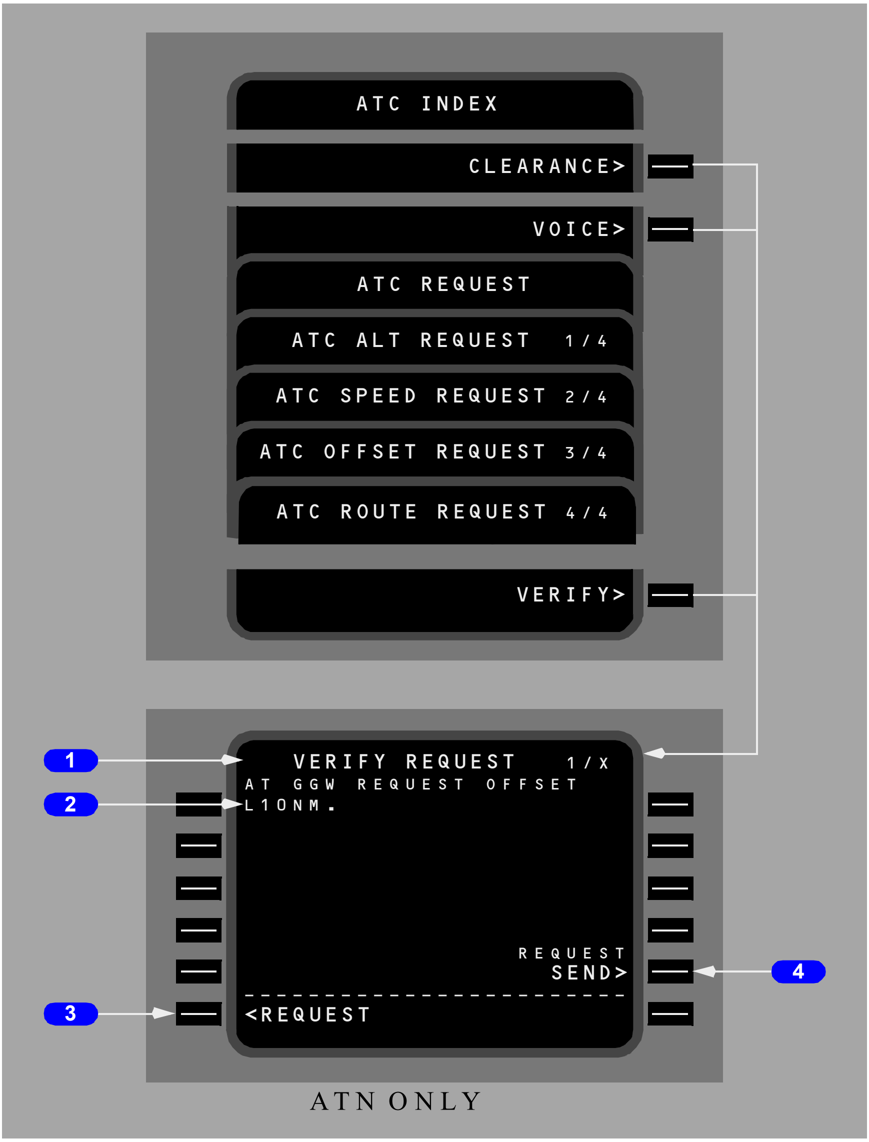
Push – displays WHEN CAN WE EXPECT page.

3 REQUEST SEND

Displays on last VERIFY REQUEST page.

Push –

- initiates ATC request
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays XXXXZ ATC REQUEST page upon network acknowledgement
- displays NO ATC COMM when data link READY and no ATC connection
- displays NO COMM for no available communications media.



1 VERIFY REQUEST (ATN)

The VERIFY REQUEST page displays the text of the message which will be downlinked to ATC for an altitude, speed, offset, or route clearance request.

If this page is accessed via the VERIFY prompt on the ATC REQUEST, ATC ALT REQUEST, ATC SPEED REQUEST, ATC OFFSET REQUEST, or ATC ROUTE REQUEST pages, then only those message elements associated with the requests formulated via these pages are displayed.

Note: Upon inter-center transfer from an ATN Center to a FANS Center and vice versa, the VERIFY REQUEST page will revert to the ATC INDEX page.

2 Lines 1 – 5

Pages 1/X to X/X display data which reflect the message elements for the altitude, speed, offset, or route clearance request.

3 ATC INDEX or REQUEST

Displays ATC INDEX when page accessed from ATC INDEX page.

Displays REQUEST when page accessed from ATC REQUEST page.

REQUEST –

Push – displays ATC REQUEST page.

ATC INDEX –

Push – displays ATC INDEX page.

4 REQUEST SEND

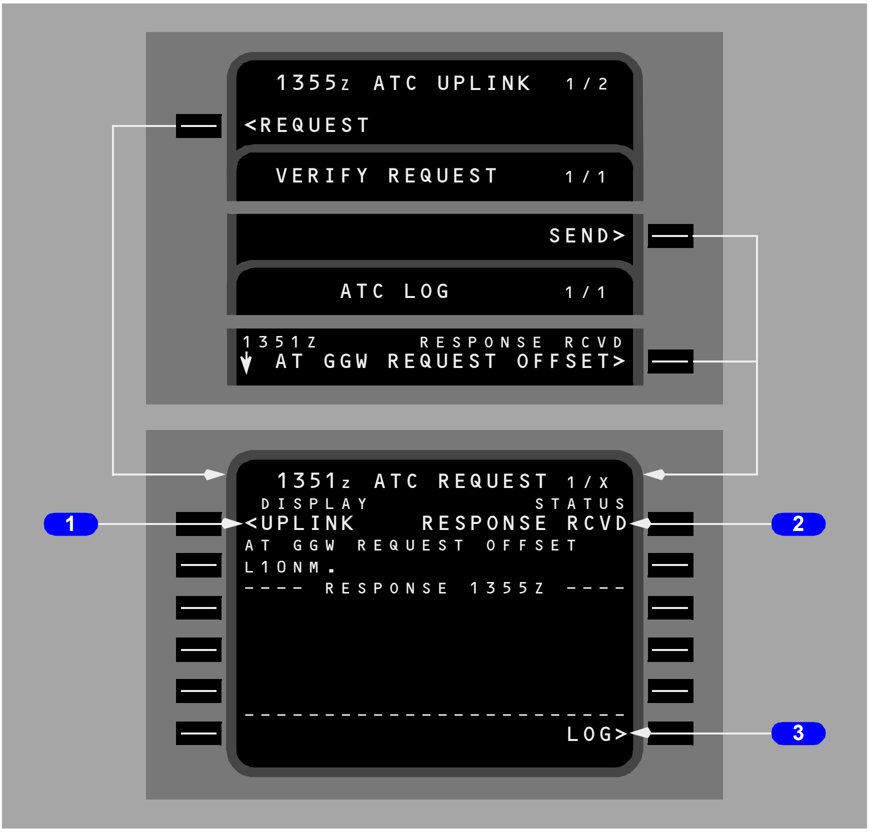
Displays on last VERIFY REQUEST page.

Push –

- results in the creation of a REQUEST message containing the information displayed on the VERIFY REQUEST page and will initiate transmission of the REQUEST message to the active ATC center.
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays XXXXZ ATC REQUEST page upon network acknowledgement
- displays NO COMM when data link status is NO COMM
- displays VOICE when data link status is VOICE
- displays FAIL when data link status is FAIL
- displays READY when data link READY and not ATN READY connection
- displays NO ATC COMM when data link READY and no ATC connection
- displays NO ATC COMM when data link ATN READY and no ATC connection
- displays NO COMM for no available communications media.

XXXXZ ATC Request Page X/X

The ATC REQUEST pages display the transmitted request. XXXXZ is the time request was transmitted.



1 Lines 1 – 5

Pages 1/X to X/X display data transmitted to ATC at the time in page title.

Page 1/X line 1 displays UPLINK when ATC response to displayed downlink request exists.

Time of ATC uplink response displays following text:

UPLINK –

Push – displays the XXXXZ ATC UPLINK 1/X page displaying ATC response to displayed request.

2 **Message Status**

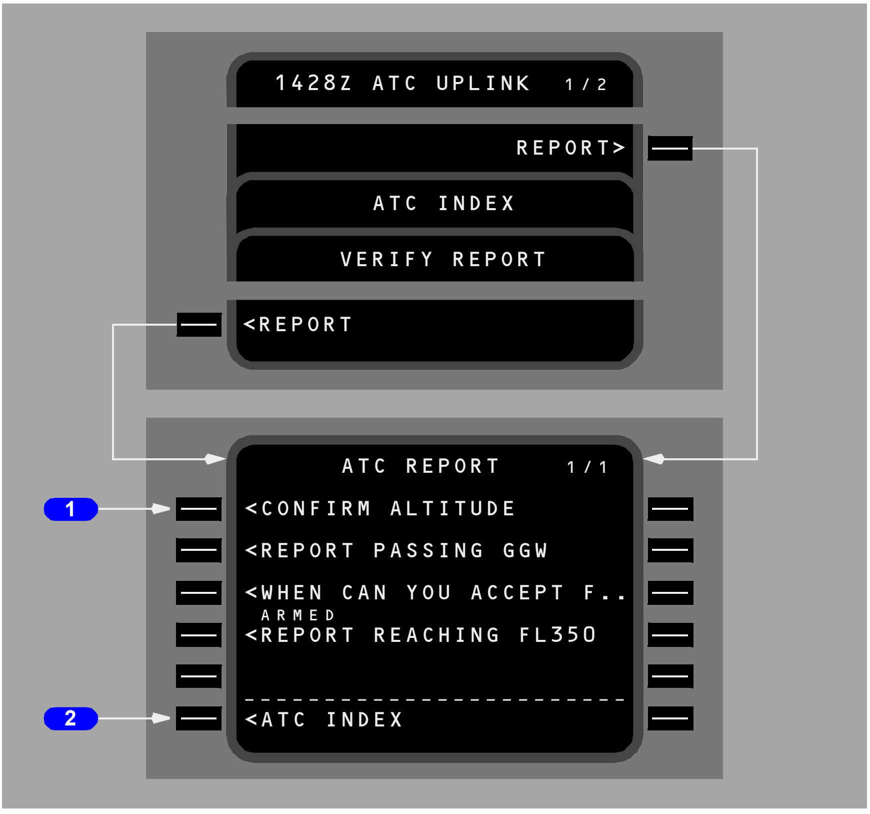
Displays request downlink message status from ATC LOG page.

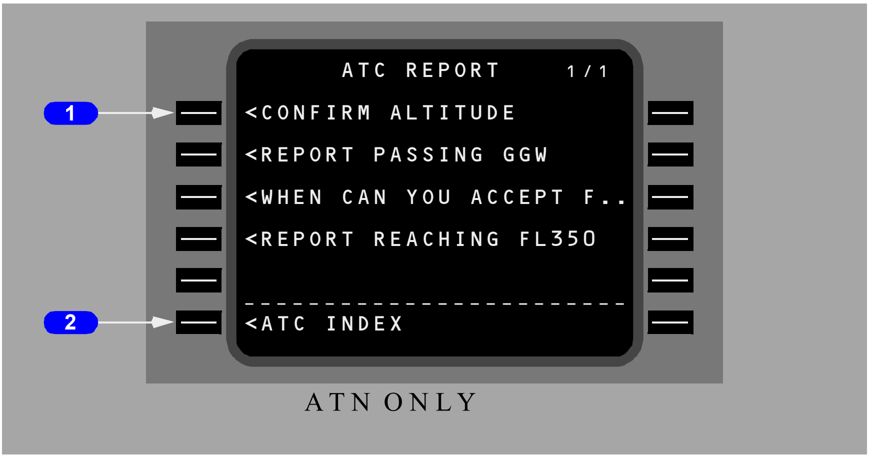
3 **LOG**

Displays ATC LOG page.

ATC Report Page X/X

The ATC REPORT pages provide access to VERIFY REPORT pages for ATC requested reports and confirmations. The ATC REPORT pages can display a maximum of 10 reports after which the ATC REPORT LIST FULL scratch pad message is displayed.





1 **Lines 1 – 5**

Pages 1/X to X/X lines 1 to 5 display uplinked report or confirmation requests transmitted by ATC.

Long messages are abbreviated and followed by two periods.

Title displays ARMED when report armed for automatic transmission.

Report or confirmation request –

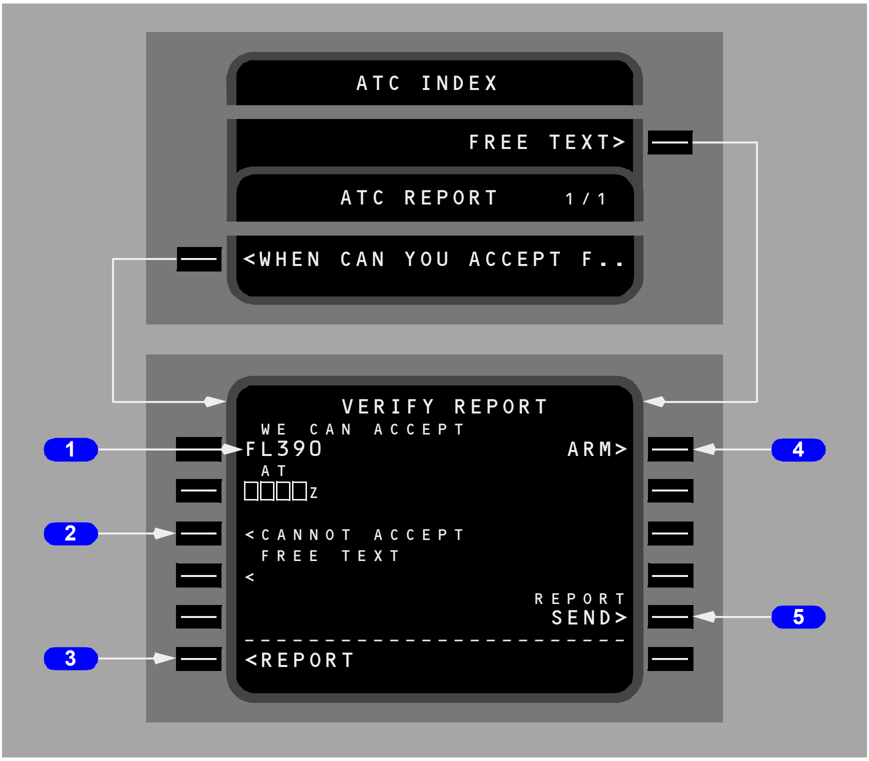
Push – displays ATC requested report or confirmation VERIFY REPORT page.

2 **INDEX**

Push – displays ATC INDEX page.

Verify Report Page

The VERIFY REPORT page displays reports in clearance language and allows review/modification and entry of free text before report is sent.



ATN ONLY

1 **Lines 1 – 4**

Display message text and data for each message.

Display boxes for pilot entry.

Entry includes data in report message.

Entry may be deleted.

At least one line is available for free text entry.

2 **CANNOT ACCEPT**

Displays in response to WHEN CAN YOU ACCEPT uplinks.

Push – selects a CANNOT ACCEPT message.

Selection may be deleted.

3 **ATC INDEX, REPORT**

Displays ATC INDEX when page accessed from ATC INDEX page.

Displays REPORT when page accessed from ATC REPORT page.

ATC INDEX –

Push – displays ATC INDEX page.

ATC REPORT –

Push – displays ATC REPORT page.

4 **ARM**

ARM is displayed when an armable report is created.

Push –

- arms report for transmission when condition is satisfied
- displays ARMED
- ARMED may be deleted to disarm transmission of report.

5 **SEND**

SEND is displayed after box prompts are filled in.

Push –

- transmits ATC REPORT
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays XXXXZ ATC REPORT page upon network acknowledgement
- displays NO ATC COMM when data link READY and no ATC connection
- displays NO COMM for no available communications media.

5 REPORT SEND

Displays on last VERIFY REPORT page.

Push –

- results in the creation of a report message containing the information displayed on the VERIFY REPORT page and initiates transmission of the report message to the active ATC center.
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays NO COMM when data link status is NO COMM
- displays VOICE when data link status is VOICE
- displays FAIL when data link status is FAIL
- displays READY when data link READY and not ATN READY connection
- displays NO ATC COMM when data link READY and no ATC connection
- displays NO ATC COMM when data link ATN READY and no ATC connection
- displays NO COMM for no available communications media.

XXXXZ ATC Report Page

XXXXZ ATC REPORT page displays the transmitted report. XXXXZ is the time the report was transmitted.

1 Lines 1 – 5

Pages 1/X to X/X display message transmitted to ATC at time of page title. Line 1 is blank on page 1/X.

2 Message STATUS

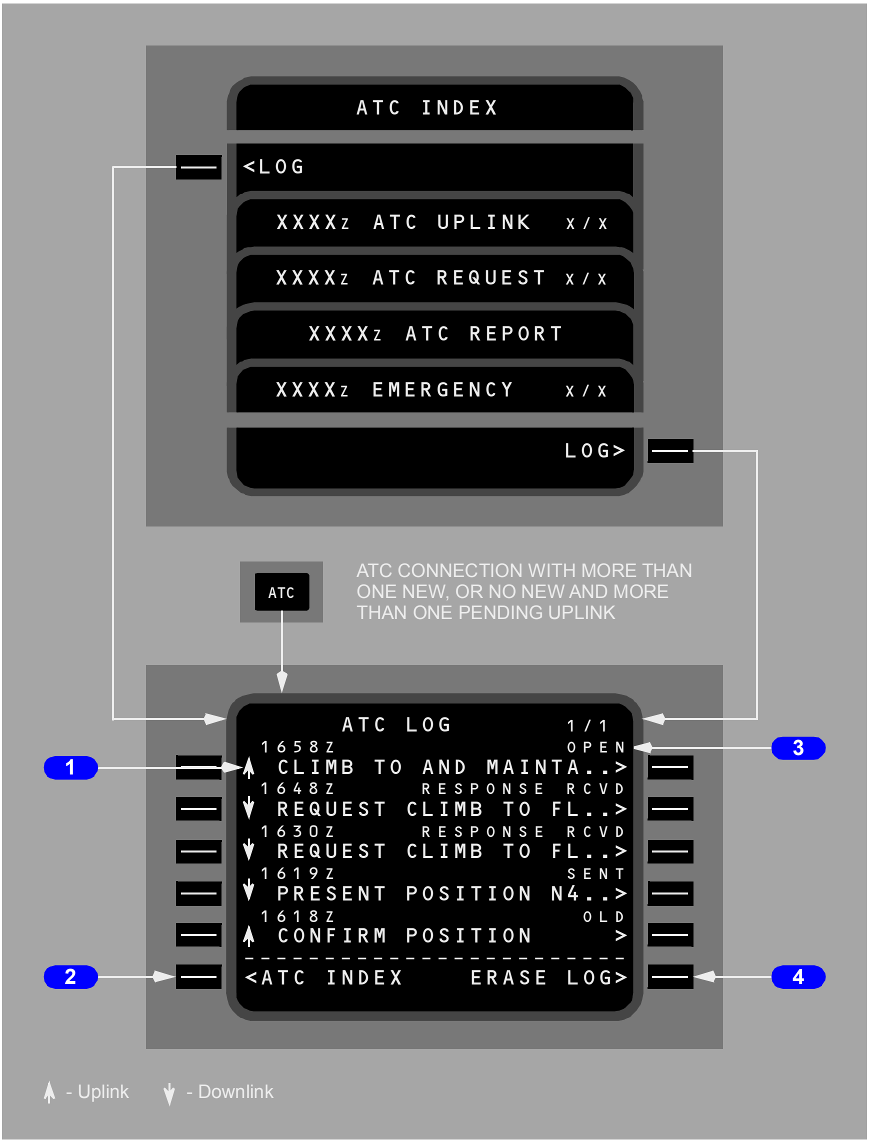
Displays ATC report status from ATC LOG page.

3 LOG

Push – Displays ATC LOG page.

ATC Log Page X/X

The ATC LOG pages display stored uplinks and downlinks. Log automatically erases after flight completion.



1 **Lines 1 – 5**

Displays text of uplink and downlink messages. Long messages are abbreviated and followed by two periods. Messages are displayed in order of receipt or transmission.

Deleting a line deletes the log entry.

Title displays message receipt (uplink) or transmission (downlink) time.

2 **ATC INDEX**

Push – Displays ATC INDEX page.

3 **Message Status**

Title displays one of seven possible uplink or six possible downlink states:

Uplink –

- NEW – message not reviewed by crew; message considered pending
- OLD – message reviewed by crew and message does not require response; message considered non–pending
- OPEN – message reviewed by crew, message requires response, crew has not sent response or has sent STANDBY; message considered pending
- ACCEPTED – message reviewed by crew, message requires response, positive response sent, network acknowledgement of positive response received; message considered non–pending
- REJECTED – message reviewed by crew, message requires response, negative response sent, network acknowledgement of negative response received; message considered non–pending
- ABORTED – message pending when all connections were terminated or transfer of communications occurred; message considered non–pending

Downlink –

- SENDING – SEND prompt selected, network acknowledgement not yet received, message considered pending. Displays SENDING in field 5R on page downlink was initiated
- SENT – SEND prompt selected, network acknowledgement received, message does not require response; message considered non–pending
- OPEN – SEND prompt selected, network acknowledgement received, message requires response, response not received or STANDBY response received, message considered pending
- DEFERRED – SEND prompt selected, network acknowledgement received, message requires response, REQUEST DEFERRED response received; message considered pending

- RESPONSE RCVD – SEND prompt selected, network acknowledgement received, message requires response, response other than STANDBY or REQUEST DEFERRED received; message considered non–pending
- ABORTED – message pending when all connections terminated; message considered non–pending.

Push – displays XXXXZ: ATC UPLINK, ATC REQUEST, ATC REPORT, or EMERGENCY page related to line selected.

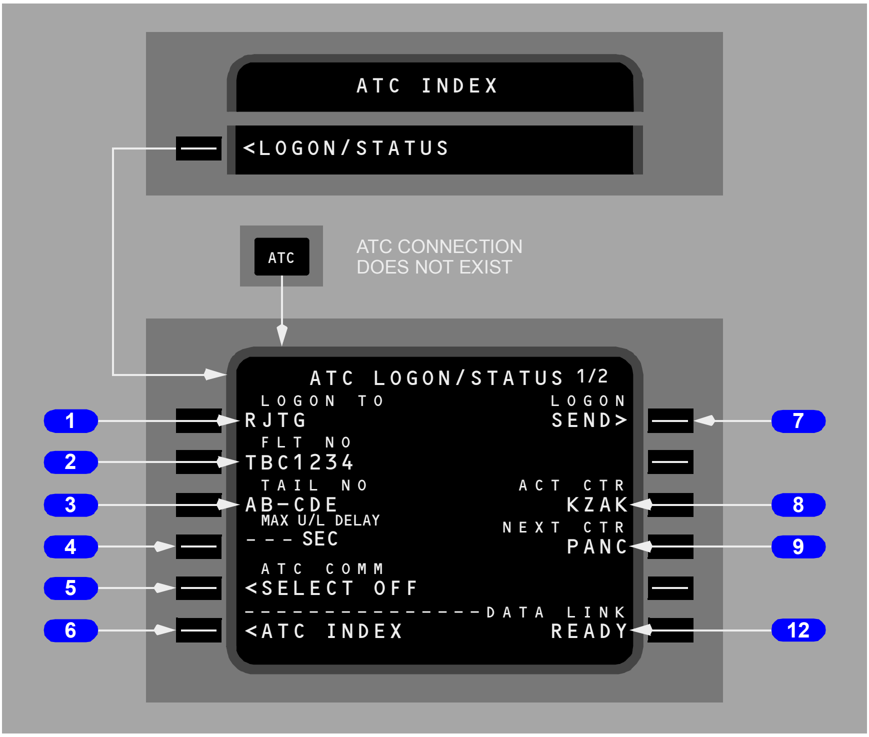
4 ERASE LOG

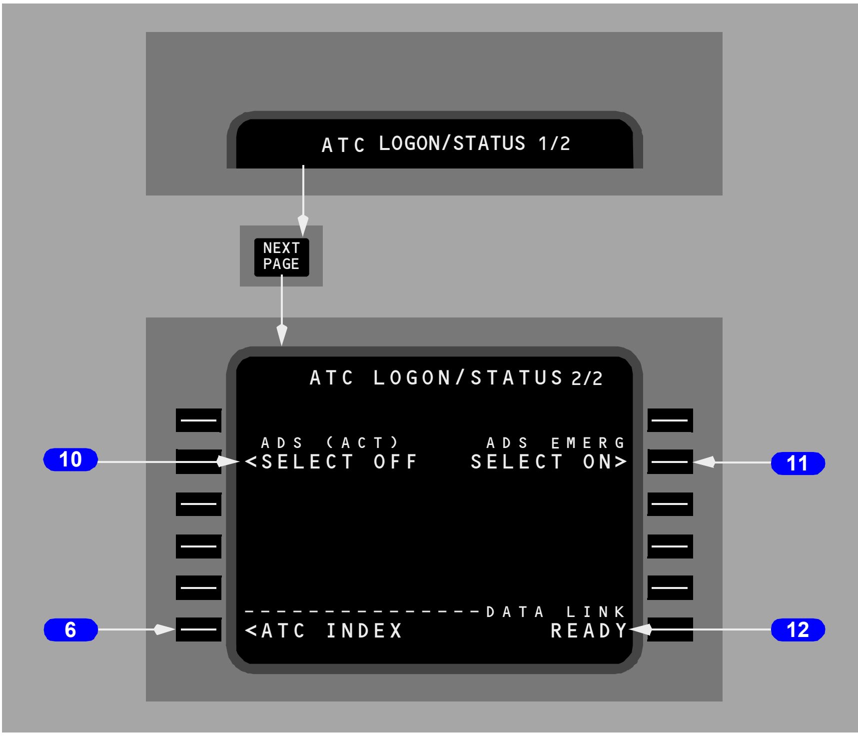
Push –

- arms deletion of all non–pending messages in the ATC Log
- displays CONFIRM
- selection of CONFIRM deletes all non–pending messages in the ATC log
- leaving the ATC Log page when CONFIRM is displayed cancels the ERASE selection.

ATC Logon/Status Page

The ATC LOGON/STATUS pages are used to initiate an ATC connection. The two pages display ADS, ATC COMM, and data link status.





1 **LOGON TO**

Initial display is boxes.

Valid entry is a four letter ATC identifier.

Entry of an identifier, a flight number, and tail number displays SEND in 1R when data link status is ready.

Deletion of identifier displays boxes and blanks SEND.

Displays dashes when ATC COMM established.

2 **Flight Number (FLT NO)**

Displays flight number from route page.

Valid entry is flight number.

Display clears at flight completion.

3 **Tail Number (TAIL NO)**

Displays airplane tail number.

Valid entry is aircraft registration number (tail number) including dash (–) characters, if applicable.

4 Max Uplink Delay (MAX U/L DELAY)

Allows the entry of 1 to 999 seconds as directed by ATC for use by the FMC to determine if the uplink is delayed more than the entered time.

5 ATC COMM

Display is blank when no ATC connection exists.

Displays SELECT OFF when ATC connection exists.

Push – terminates active ATC data link connections.

6 ATC INDEX

Push – displays ATC INDEX page.

7 LOGON SEND

Push –

- sends logon message to ATC center
- displays SENT
- displays RESEND if no response from ATC after 10 minutes
- displays ACCEPTED or REJECTED after ATC response.

8 Active Center (ACT CTR)

Displays four character identifier of active ATC center.

9 Next Center (NEXT CTR)

Displays four character identifier of next ATC center when known; otherwise, blank.

10 ADS (ARM), (ACT), (INOP), (OFF)

ADS (ARM) –

- ADS on and no ADS connection exists
- displays SELECT OFF prompt.

Push –

- terminates all ADS connections and ADS reporting
- prevents ATC from requesting ADS reporting
- displays ADS (OFF)
- displays ADS SELECT ARM prompt.

ADS (ACT) –

- ADS armed and one or more ADS connection exists
- displays SELECT OFF prompt.

Push –

- terminates all ADS connections and ADS reporting
- prevents ATC from requesting ADS reporting
- displays ADS (OFF)
- displays ADS SELECT ARM prompt.

ADS (INOP)

- ADS selected off
- no prompt displayed
- aircraft registration number (tail number) has not been entered

ADS (OFF)

- ADS selected off
- displays ADS SELECT ARM prompt.

Push –

- arms ADS reporting
- displays SELECT OFF prompt.

11 ADS Emergency (EMER)

Displays SELECT ON when ADS is not in emergency mode.

Displays SELECT OFF when ADS is in emergency mode.

Display is blank when ADS selected off.

SELECT ON –

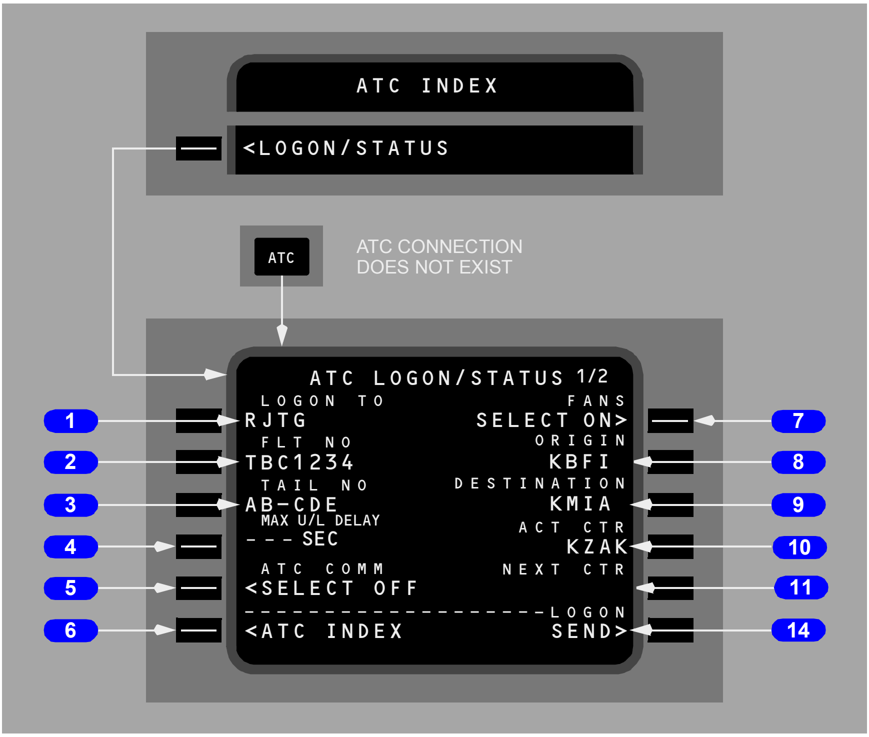
Push – initiates ADS emergency mode.

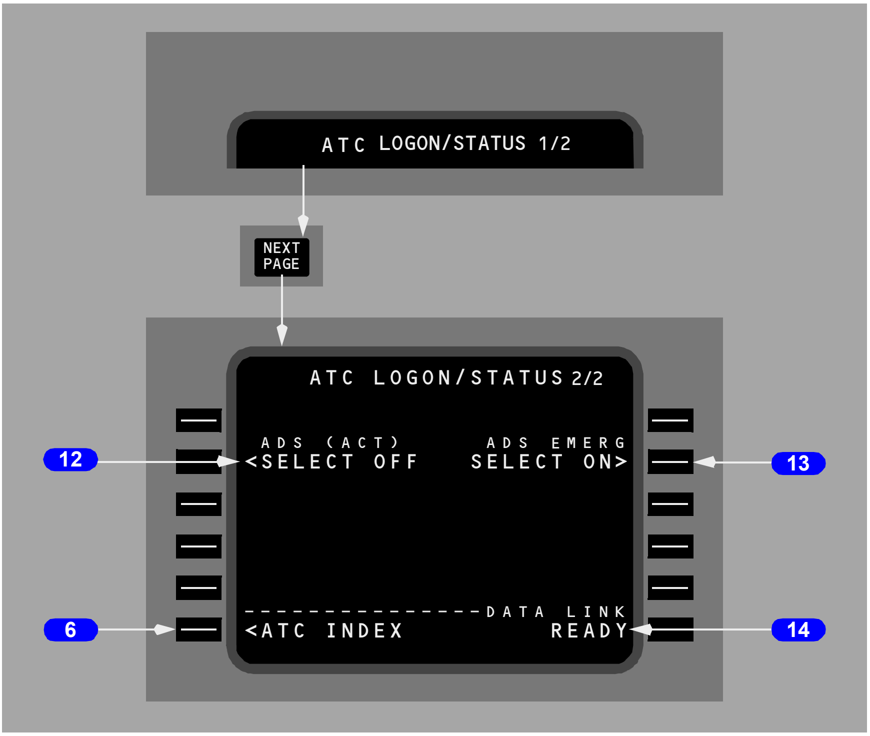
SELECT OFF –

Push – terminates ADS emergency mode.

12 DATA LINK Status

Displays status: READY, NO COMM, VOICE, or FAIL.


ATC INDEX
<LOGON/STATUS
ATC
ATC CONNECTION
DOES NOT EXIST
ATC LOGON/STATUS 1/2
LOGON TO
RJTG
FANS
SELECT ON>
FLT NO
TBC1234
ORIGIN
KBFI
TAIL NO
AB-CDE
DESTINATION
KMIA
MAX U/L DELAY
--- SEC
ACT CTR
KZAK
ATC COMM
<SELECT OFF
NEXT CTR
LOGON
<ATC INDEX
SEND>
1
2
3
4
5
6
7
8
9
10
11
14



1 LOGON TO

Entry of a four to eight characters ATC center identifier causes the FMC to use the ATC database to determine if the entered center is an Aeronautical Telecommunications Network (ATN) center.

- If an ATC database is not installed and more than a 4-character long station name is entered, INVALID ENTRY is displayed in the scratchpad.
- If an ATC database is installed and the entered 4-character center is not in the ATC database, the FMC assumes the entered center is a FANS center.
- If the entered center exists in the ATC database and FANS ON/OFF is selected OFF on the ATC Log on/Status page, its associated ground address is used for the ATN logon downlink.

If the data link status is READY, a valid entry will be four alpha characters.

- The FMC assumes the entered center is a FANS center.

When a FANS center is entered with a flight number displayed in field 2L along with a tail number in field 3L the result will be a display of the logon SEND prompt in 6R, if the data link status is READY or ATN READY or ATN ONLY.

When an ATN center is entered with a flight number displayed in field 2L, a tail number in field 3L, an origin in field 2R, and a destination in field 3R the result will be a display of the logon SEND prompt in 6R, if the data link status is ATN READY or ATN ONLY.

- When a four character center (that is in the ATN Database) is entered and a flight number is displayed in field 2L along with a tail number in field 3L the result is a display of the FANS SELECT ON prompt in 1R, if the data link status is READY.
- Entry of an ATC center over a displayed ATC center resets the 6R display to SEND> if SENDING, RESEND, SENT, ACCEPTED, or REJECTED was displayed in field 6R at the time of entry.

Selection of DELETE to 1L when an ATC center identifier is displayed will display:

- Box prompts - if a Logon was not accepted before.
- Dashes - if a Logon was not accepted before.

When present position is invalid, the data line displays blanks.

2 Flight Number (FLT NO)

Entry of a valid flight number over the default when a FANS ATC center identifier is displayed in field 1L and a tail number is displayed in 3L results in display of the logon SEND prompt in 6R, if the data link status is READY or ATN READY or ATN ONLY.

Entry of a valid flight number over the default when an ATN ATC center identifier is displayed in field 1L, a tail number is displayed in 3L, an origin is displayed in field 2R, and a destination is displayed in field 3R results in display of the logon SEND prompt in 6R, if the data link status is ATN READY or ATN ONLY.

Entry of a flight number can be manually entered or by loading of an AOC flight number uplink.

The flight number entered into this field is propagated to the flight number field on the route page 1/X, the PROGRESS page title, and the POS REPORT page title.

The data line defaults to the flight number entered on the route page 1/X.

Display clears at flight completion.

3 Tail Number (TAIL NO)

Displays airplane tail number.

Valid entry is aircraft registration number (tail number) including dash (–) characters, if applicable.

4 **Max Uplink Delay (MAX U/L DELAY)**

Allows the entry of 1 to 999 seconds as directed by ATC for use by the FMC to determine if the uplink is delayed more than the entered time.

5 **ATC COMM**

Display is blank when no ATC connection exists.

Displays SELECT OFF when ATC connection exists.

Push – terminates active ATC data link connection

6 **ATC INDEX**

Push – displays ATC INDEX page.

7 **FANS SELECT ON/OFF**

Selection of the 1R line select key when SELECT ON> is displayed puts the logon in FANS Mode (i.e. use FANS for logon).

Selection of the 1R line select key when SELECT OFF> is displayed shall put the logon in ATN Mode (i.e. use FANS for logon).

8 **ORIGIN**

Entry of an Origin can be from manual entry or propagated from the Route page.

The newly entered Origin on the Route page will be propagated to this page and overwrite the current data on this field.

An Origin manually entered into this field will not be propagated to the Origin field on the route page.

9 **DESTINATION**

Entry of an Destination can be from manual entry or propagated from the Route page.

The newly entered Destination on the Route page will be propagated to this page and overwrite the current data on this field.

A Destination manually entered into this field will not be propagated to the Destination field on the route page.

If no Destination has been entered on the route page, then four box prompts will be displayed.

10 **Active Center (ACT CTR)**

Displays four to eight character identifier of active ATC center.

11 Next Center (NEXT CTR)

Displays four to eight character identifier of next ATC center when known; otherwise, blank.

12 ADS (ARM), (ACT), (INOP), (OFF)

ADS (ARM) –

- ADS on and no ADS connection exists
- displays SELECT OFF prompt.

Push –

- terminates all ADS connections and ADS reporting
- prevents ATC from requesting ADS reporting
- displays ADS (OFF)
- displays ADS SELECT ARM prompt.

ADS (ACT) –

- ADS armed and one or more ADS connection exists
- displays SELECT OFF prompt.

Push –

- terminates all ADS connections and ADS reporting
- prevents ATC from requesting ADS reporting
- displays ADS (OFF)
- displays ADS SELECT ARM prompt.

ADS (INOP)

- ADS selected off
- no prompt displayed
- aircraft registration number (tail number) has not been entered

ADS (OFF)

- ADS selected off
- displays ADS SELECT ARM prompt.

Push –

- arms ADS reporting
- displays SELECT OFF prompt.

13 ADS Emergency (EMER)

Displays SELECT ON when ADS is not in emergency mode.

Displays SELECT OFF when ADS is in emergency mode.

Display is blank when ADS selected off.

SELECT ON –

Push – initiates ADS emergency mode.

SELECT OFF –

Push – terminates ADS emergency mode.

14 Data Link Status, Logon SEND prompt, and Logon Status Field

Selection of the 6R line select key when the logon SEND or RESEND prompt is displayed will initiate transmission of the logon message downlink to the ATC center specified in field 1L.

DATA LINK display states: READY, ATN READY, ATN ONLY, NO COMM, VOICE and FAIL.

When the data link status is READY or ATN READY and either of the following conditions occur:

- a FANS ATC center entry is made into 1L when 2L displays a flight number and 3L displays a tail number, or
- an entry is made into 2L when 1L displays an a FANS ATC center identifier and 3L displays a tail number.

Then the line title changes from DATA LINK to LOGON and the data line displays SEND > at 6R.

When the data link status is ATN READY or ATN Only and either of the following conditions occur:

- a ATN ATC center entry is made into 1L when 2L displays a flight number, 3L displays a tail number, 2R displays an Origin, and 3R displays a Destination, or
- an entry is made into 2L when 1L displays an ATN ATC center identifier, 3L displays a tail number, 2R displays an Origin, and 3R displays a Destination.

Then the line title changes from DATA LINK to LOGON and the data line displays SEND > at 6R.

After selection of the logon SEND prompt and before a network acknowledgment/logical acknowledgement to the logon requested downlink message has been received and before network timeout, the data line changes to SENDING. If the logon request downlink message is not received within the time-out period then the data line changes to RESEND.

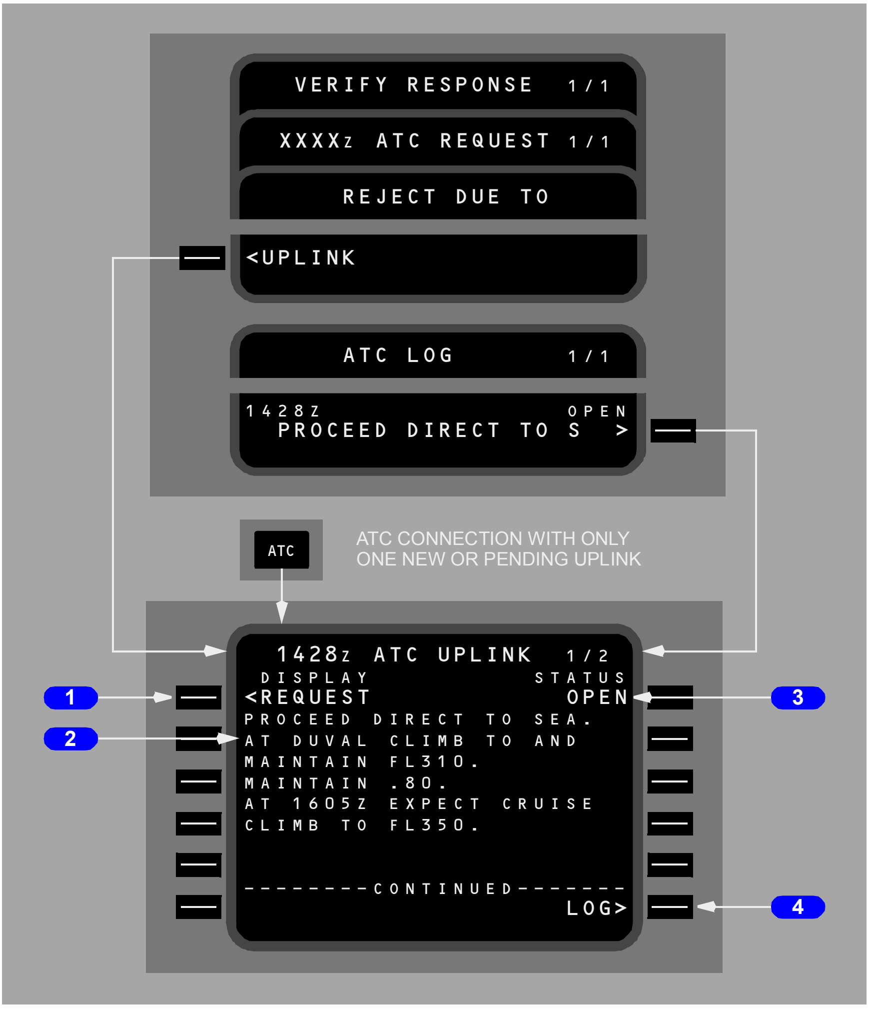
After a positive acknowledgment message to the logon request downlink message has been received from ATC within logon timeout period, the data line changes to ACCEPTED.

After a negative acknowledgment message to the logon request downlink message has been received from ATC within a logon timeout period, the data line changes to REJECTED.

Note: Termination of the active ATC COMM connection either by means of receipt of an END SERVICE uplink (whether or not a transfer of comm occurs) or selection of the ATC COMM OFF prompt in field 5L, has no affect on the 6R display state.

XXXXZ ATC Uplink Page 1/X

The ATC UPLINK pages display messages uplinked by ATC. The pages provide the capability to respond to uplinked messages and to load clearances.



1 REQUEST

Displays REQUEST when displayed uplink is in response to a downlink request not deleted from the ATC log.

Push – displays the related XXXXZ ATC REQUEST page.

Title displays message receipt time.

2 Message Text

Lines 2 to 5 of XXXXZ ATC uplink page 1/X display text of uplinked ATC message.

3 STATUS

Displays status of ATC uplink message from ATC log page.

4 LOG, REPORT

Displays LOG when uplink message does not include a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request.

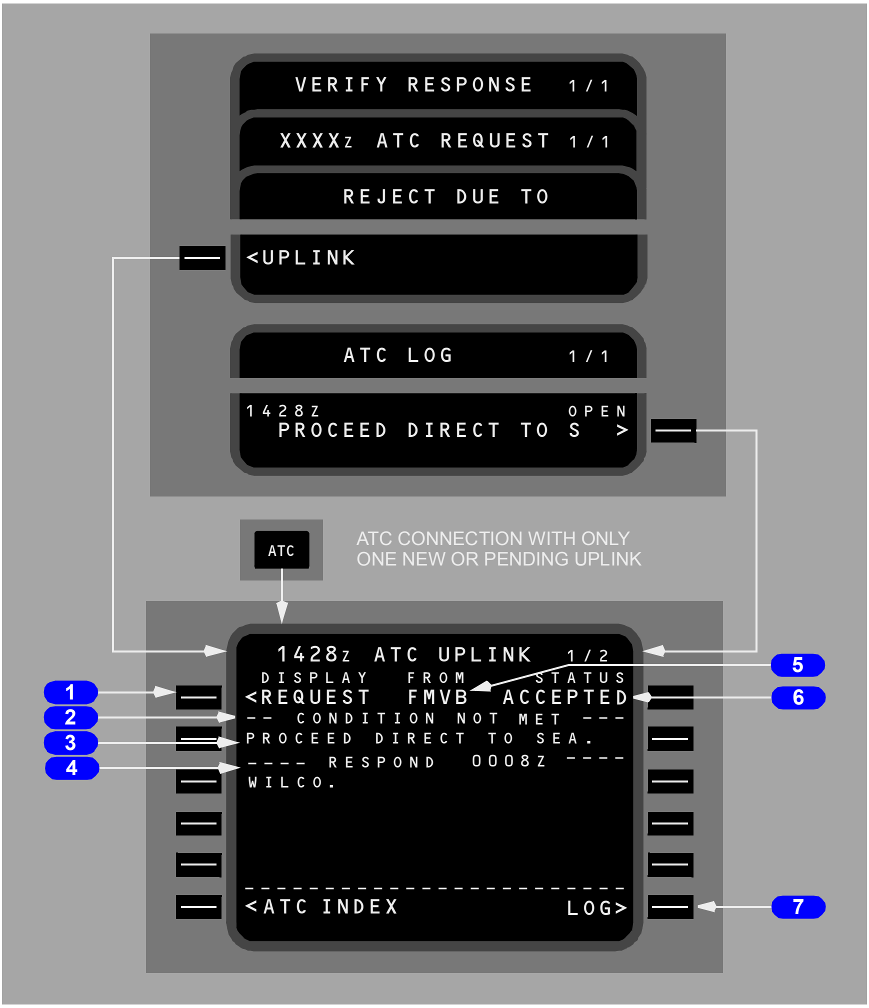
Displays REPORT when uplink message includes a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request.

LOG –

Push – displays ATC LOG page.

REPORT –

Push – displays ATC REPORT page.



1 REQUEST prompt and ATC Center (first page only)

Displays REQUEST when displayed uplink is in response to a downlink request not deleted from the ATC log.

Push – displays the related XXXXZ ATC REQUEST page.

Title displays message receipt time.

2 Conditional Clearances

Conditional clearances are uplinks that contain a conditional location, altitude, or time for execution of a clearance/instruction. The system is able to handle up to 3 accepted conditional clearances.

If an accepted conditional clearance is executed early, the FMC displays the following:

- “CLEARANCE COND NOT MET” scratchpad message.
- “CONDITION NOT MET” displayed in the 2L/2R line title.

The annunciation of early execution of a conditional clearance is triggered by:

- If the MCP altitude changes more than +/- 150 feet from the current altitude prior to satisfying the condition (time or position), then a conditional altitude clearance is considered to have been executed early.
- If an offset is executed including deleting an existing offset before the specified [time], then the conditional offset clearance is considered to have been executed early.
- If the direct waypoint becomes the active waypoint prior to satisfying the condition (time or altitude), then a conditional direct clearance is considered to have been executed early.

Note: The annunciation of early execution of a conditional clearance is not provided for a conditional heading clearance.

When the airplane satisfies the condition associated with a conditional clearance, a “clearance condition met” message is displayed as follows:

- “CLEARANCE COND MET” scratchpad message.
- “CONDITION MET” displayed in the 2L/2R line title.

The annunciation of execution of a conditional clearance is triggered by:

- the condition is considered satisfied when the current time reaches the specified time.
- the condition is considered satisfied when the specified waypoint is sequenced in the FMS active route.
- the condition is considered satisfied when the airplane reaches an altitude within +/- 150 ft of the specified altitude.
- The conditional clearance is manually deleted by selection of DELETE to 1L, 2L or 3L on the CONDITIONAL CLEARANCE page.

3 Message Text

Lines 2 to 5 of XXXXZ ATC uplink page 1/X display text of uplinked ATC message.

4 RESPONSE XXXXZ

XXXXZ is the time at which the flight crew initiated transmission of the response to ATC.

The text of the response message is displayed beginning in the first available line (header or data line) following the RESPONSE XXXXZ line.

- If the crew response was to ACCEPT the uplink, then WILCO, ROGER, or AFFIRM, as appropriate for the associated uplink, is displayed.
- If the crew response was to REJECT the uplink, then UNABLE or NEGATIVE, as appropriate for the associated uplink, is displayed.
- If the crew response was to REJECT the uplink and a reject reason was selected or entered as free text on the REJECT DUE TO page, then the text of the reject reason is displayed following the response message element text in the order selected on the REJECT DUE TO page.
- If the UNLOADABLE CLEARANCE prompt was selected on the REJECT DUE TO page, then UNLOADABLE CLEARANCE is displayed.
- If the NOT CONSISTENT. RESEND prompt was selected on the REJECT DUE TO page, then NOT CONSISTENT. RESEND is displayed.
- If the DUE TO PERFORMANCE prompt was selected on the REJECT DUE TO page, then DUE TO AIRCRAFT PERFORMANCE is displayed.
- If the DUE TO WEATHER prompt was selected on the REJECT DUE TO page, then DUE TO WEATHER is displayed.
- If any free text was entered on the REJECT DUE TO page, then that text is displayed.

5 ATC Center

The data line displays the ATC Center, who uplinked the message, (4 characters in FANS, and 4-8 characters in ATN). For centers with more than 4 characters, only the first 4 characters will be displayed.

6 STATUS

Displays status of ATC uplink message from ATC log page.

7 LOG, REPORT

Displays LOG when uplink message does not include a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request.

Displays REPORT when uplink message includes a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request.

LOG –

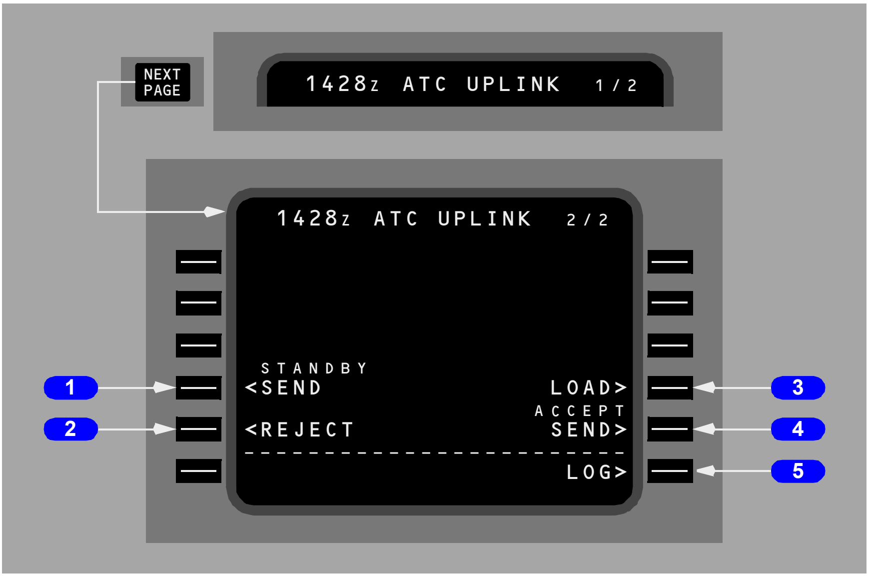
Push – displays ATC LOG page.

REPORT –

Push – displays ATC REPORT page.

XXXXZ ATC Uplink Page X/X

Last XXXXZ ATC UPLINK page continues text of uplinked ATC message. Page provides capability to respond to uplinked messages and to load clearances.



1 STANDBY

Displays STANDBY when response is required until response has been made.

Push – sends standby response.

2 REJECT

Displays REJECT when UNABLE or NEGATIVE is a valid response until response has been made.

Push – displays REJECT DUE TO page.

3 LOAD

Displays LOAD when uplink message has loadable data.

Push – loads data into route X.

4 ACCEPT

Displays ACCEPT when WILCO, ROGER, or AFFIRM is a valid response until response has been made.

Push – sends a WILCO, ROGER or AFFIRM response.

5 LOG, REPORT

Displays LOG when uplink message does not include a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request.

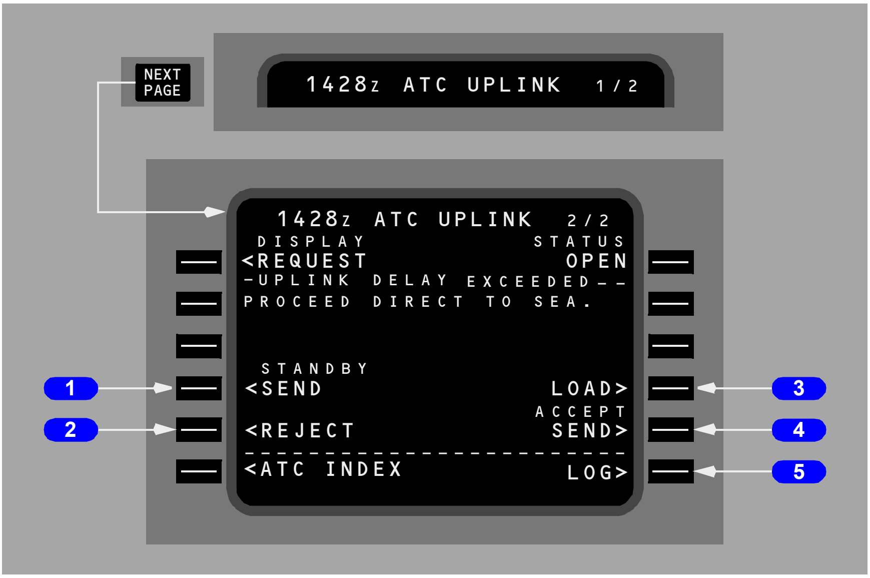
Displays REPORT when uplink message includes a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request.

LOG –

Push – displays ATC LOG page.

REPORT –

Push – displays ATC REPORT page.



1 STANDBY

Displays STANDBY when response is required until response has been made.

Push – sends standby response.

2 REJECT

Displays REJECT when UNABLE or NEGATIVE is a valid response until response has been made.

Push – displays REJECT DUE TO page.

3 LOAD

Displays LOAD when uplink message has loadable data.

Push – loads data into route X.

4 ACCEPT

Displays ACCEPT when WILCO, ROGER, or AFFIRM is a valid response until response has been made.

Push – sends a WILCO, ROGER or AFFIRM response.

5 LOG, REPORT

Displays LOG when uplink message does not include a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request.

Displays REPORT when uplink message includes a REPORT, CONFIRM, or WHEN CAN YOU ACCEPT request.

LOG –

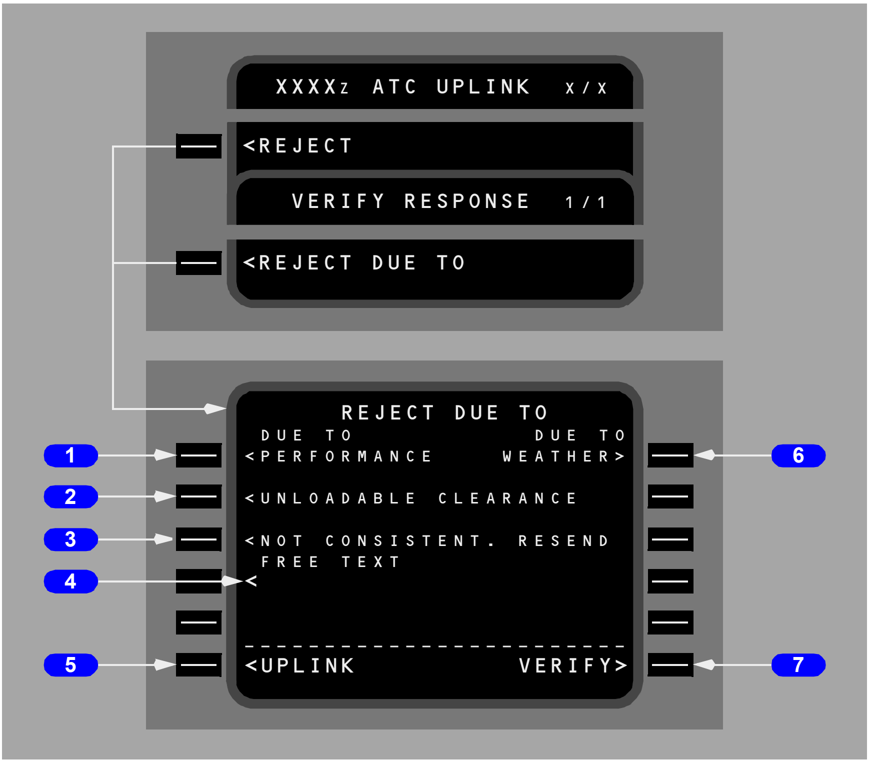
Push – displays ATC LOG page.

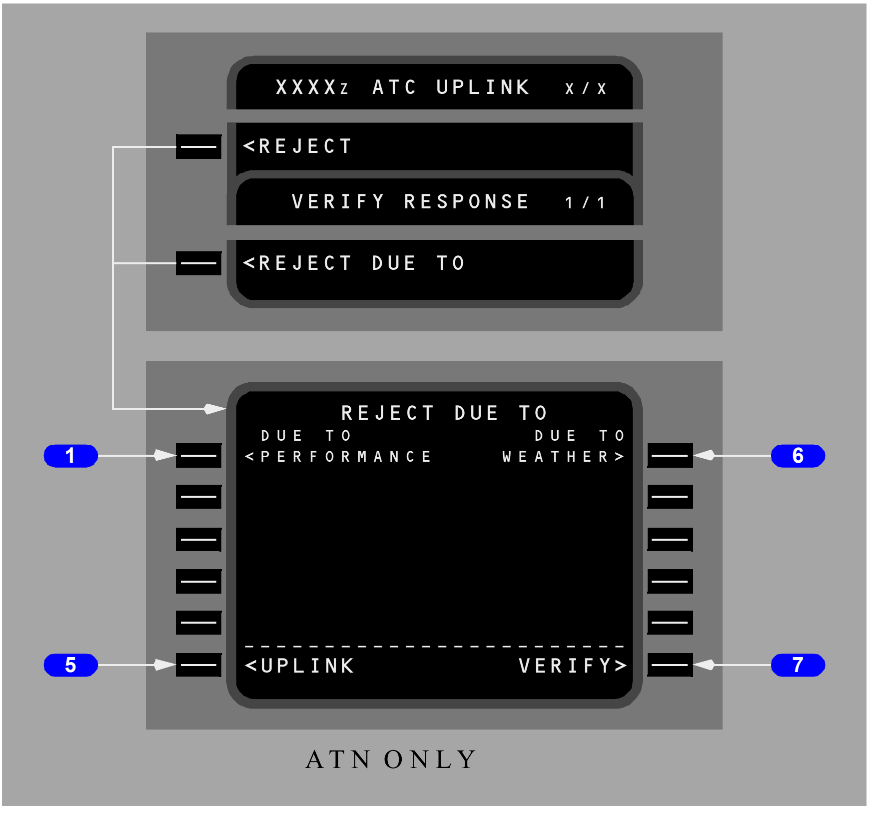
REPORT –

Push – displays ATC REPORT page.

Reject Due To Page

The REJECT DUE TO page is used to include a reason for rejection of an ATC UPLINK message.





1 DUE TO PERFORMANCE

Initially displays PERFORMANCE in small font.

Push – selects DUE TO AIRCRAFT PERFORMANCE message element in response downlink message.

2 UNLOADABLE CLEARANCE

Initially displays UNLOADABLE CLEARANCE in small font.

Push – selects UNLOADABLE CLEARANCE message element in response downlink message.

3 NOT CONSISTENT. RESEND

Initially displays NOT CONSISTENT. RESEND in small font.

Push – selects NOT CONSISTENT. RESEND message element in response downlink message.

4 **FREE TEXT**

Text entered on line 4 is included in response message.

Initial display is blank with a caret.

5 **UPLINK**

Push – displays XXXXZ ATC UPLINK page.

6 **DUE TO WEATHER**

Initially displays WEATHER in small font.

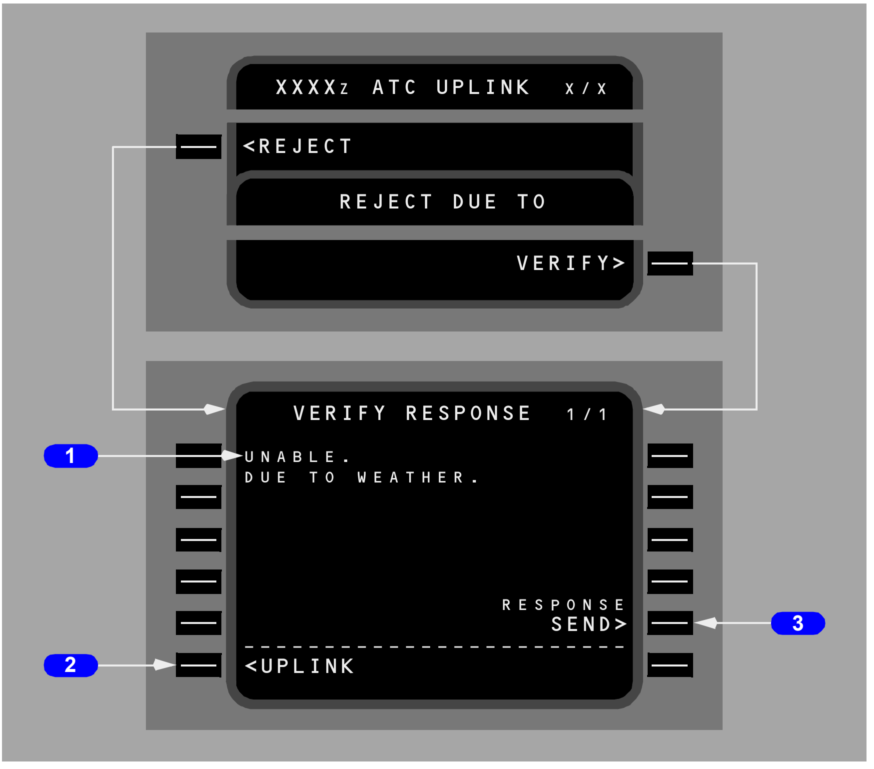
Push – selects DUE TO WEATHER message element in response downlink message.

7 **VERIFY**

Push – displays VERIFY RESPONSE page.

Verify Response Page

The VERIFY RESPONSE page provides capability to review content of rejection messages.



1 Lines 1 – 5

Displays UNABLE or NEGATIVE, as appropriate, for associated uplink.

If reject reason was selected or entered as free text on the REJECT DUE TO page, the text of the reject message is displayed in the order selected. Examples include: DUE TO PERFORMANCE, DUE TO WEATHER, UNLOADABLE CLEARANCE, NOT CONSISTENT, or free text entered on 4L.

2 UPLINK, REJECT DUE TO

UPLINK –

Push – displays XXXXZ ATC UPLINK page.

REJECT DUE TO –

Push – displays REJECT DUE TO page.

3 RESPONSE SEND

Push –

- transmits downlink response to ATC uplink message
- appends text of downlink response to end of uplink message
- displays SENDING
- displays XXXXZ ATC UPLINK page upon network acknowledgement
- displays NO ATC COMM when data link READY and no ATC connection
- displays NO COMM for no available communications media.

3 RESPONSE SEND

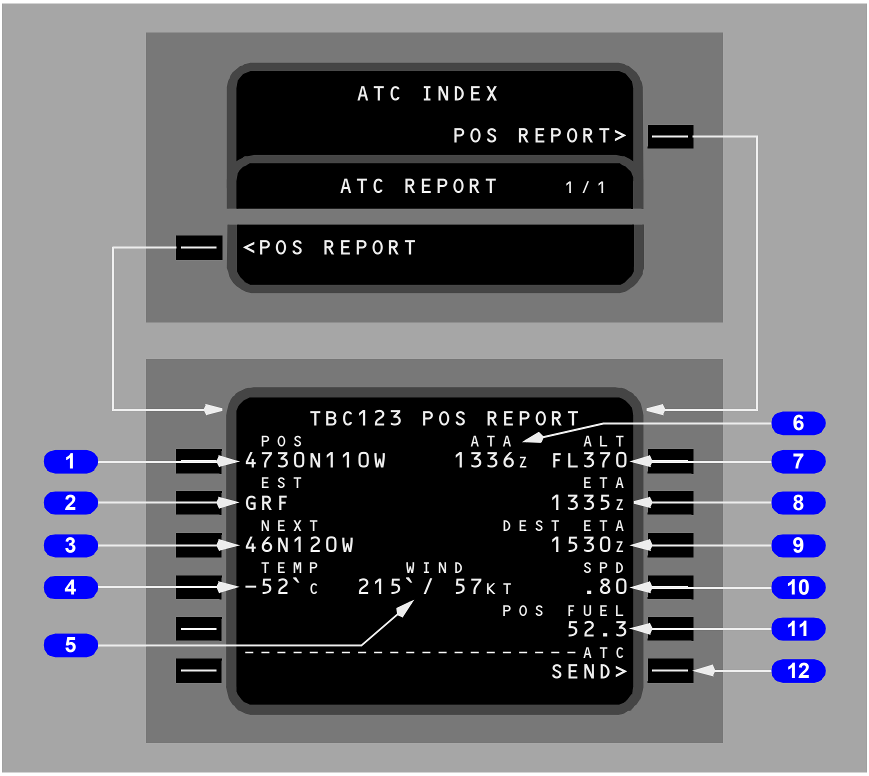
Displays on last VERIFY RESPONSE page.

Push –

- creates a rejection response message containing the information displayed on the VERIFY RESPONSE page and will initiate transmission of the response message to the active ATC center.
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays NO COMM when data link status is NO COMM
- displays VOICE when data link status is VOICE
- displays FAIL when data link status is FAIL
- displays READY when data link READY and not ATN READY connection
- displays NO ATC COMM when data link READY and no ATC connection
- displays NO ATC COMM when data link ATN READY and no ATC connection
- displays NO COMM for no available communications media.

XXXX Position Report Page

The XXXX POS REPORT page allows review and sending of position reports to ATC. XXXX is the flight number.



1 LAST Waypoint (POS)

Displays waypoint identifier for last sequenced leg.

2 TO Waypoint (EST)

Displays waypoint identifier of current leg.

Valid entries are waypoint identifiers in the navigation database or defined geographic points.

Entry overrides displayed waypoint.

Deletion of entry returns current leg waypoint.

3 NEXT Waypoint

Displays waypoint identifier of leg following the TO leg.

Valid entries are waypoint identifiers in the navigation database or defined geographic points.

Entry overrides displayed waypoint.

Deletion of entry returns default waypoint.

4 Temperature (TEMP)

Displays current static air temperature.

5 WIND

Displays current wind direction and magnitude.

6 Actual Time of Arrival (ATA)

Displays ATA at last sequenced waypoint.

7 Altitude (ALT)

Displays altitude at last sequenced waypoint.

8 Estimated Time of Arrival (ETA)

Displays ETA at TO waypoint.

Valid entry is HHMM (HH is hours and MM is minutes).

Entry overrides displayed time.

Deletion of entry returns default time.

9 Destination Estimated Time of Arrival (DEST ETA)

Displays ETA at destination.

Valid entry is HHMM (HH is hours and MM is minutes).

Entry overrides displayed time.

Deletion of entry returns default time.

10 Speed (SPD)

Displays current Mach number.

Valid entry is between.61-.82 Mach.

Entry overrides displayed Mach number.

Deletion or page change returns default Mach number.

11 FUEL (POS FUEL)

Displays fuel remaining when the POS REPORT page 1L waypoint was sequenced.

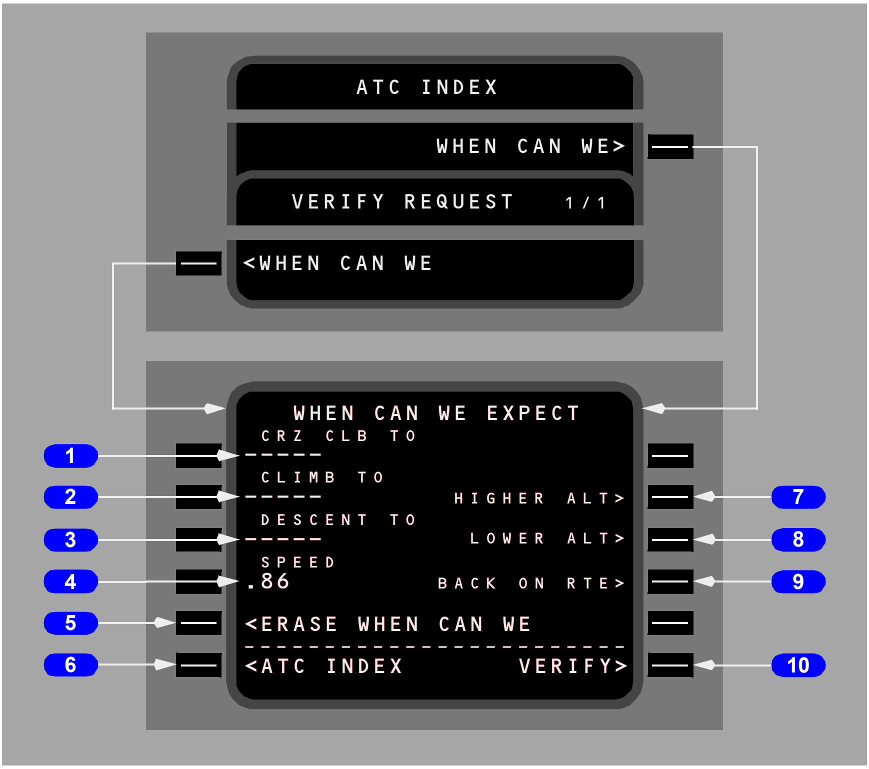
12 ATC SEND

Push –

- sends downlink position report to ATC
- creates ATC LOG entry of transmitted message
- displays SENDING
- displays SENT upon network acknowledgement
- displays NO ATC COMM when data link READY and no ATC connection
- displays NO COMM for no available communications media.

When Can We Expect Page

The WHEN CAN WE EXPECT page allows query to ATC about when to expect a certain clearance.



1 Cruise Climb To (CRZ CLB TO)

Entry of an altitude selects a message querying ATC when to expect a cruise climb to the entered altitude.

Valid entry is XXX or FLXXX (flight level), XXXXX (feet), or XXXXXm (meters).

Entry may be deleted.

2 CLIMB TO

Entry of an altitude selects a message querying ATC when to expect a climb to the entered altitude.

Valid entry is XXX or FLXXX (flight level), XXXXX (feet), or XXXXXm (meters).

Entry may be deleted.

3 DESCENT TO

Entry of an altitude selects a message querying ATC when to expect a descent to the entered altitude.

Valid entry is XXX or FLXXX (flight level), XXXXX (feet), or XXXXXm (meters).

Entry may be deleted.

4 SPEED

Entry of a speed selects a message querying ATC when to expect the entered speed.

Valid entry is IAS or Mach.

Entry may be deleted.

5 ERASE WHEN CAN WE

Push – erases all entered or selected data and returns default values.

6 ATC INDEX

Push – displays ATC INDEX page.

7 HIGHER Altitude (ALT)

Push – selects a message querying ATC when to expect a higher altitude.

Selection may be deleted.

8 LOWER Altitude (ALT)

Push – selects a message querying ATC when to expect a lower altitude.

Selection may be deleted.

9 BACK ON Route (RTE)

Push – selects a message querying ATC when to expect to be cleared back on route.

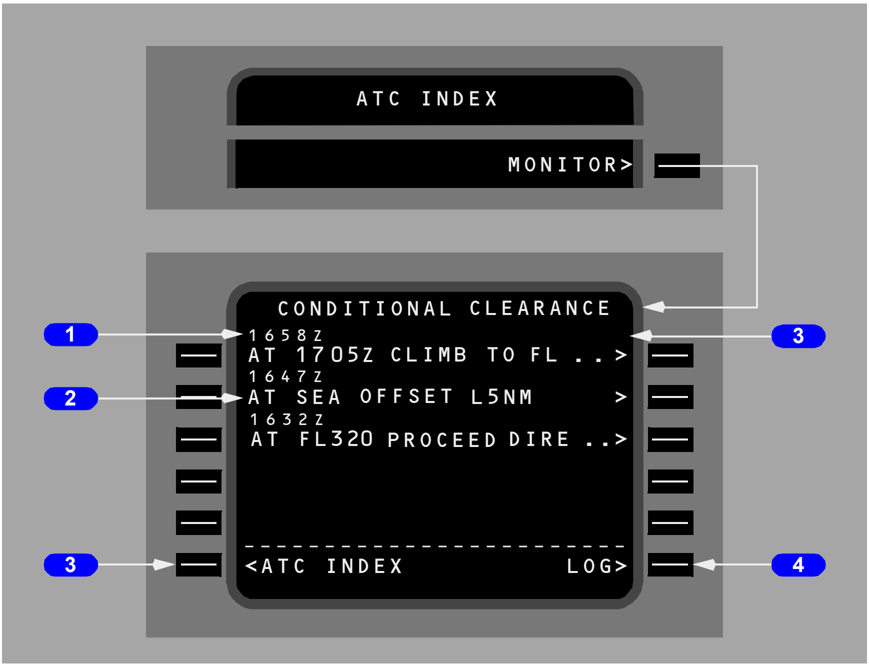
Selection may be deleted.

10 VERIFY

Push – displays VERIFY REQUEST page.

CONDITIONAL CLEARANCE page

The CONDITIONAL CLEARANCE page provides a log of all conditional clearance uplinks that are being monitored by the system. Conditional clearances are uplinks that contain a conditional location, altitude, or time for execution of a clearance/instruction.



1 XXXXZ (time)

Time of message receipt.

2 Conditional Clearances

The system is able to handle up to 3 accepted conditional clearances.

If an accepted conditional clearance defined by uplink elements is executed early, the FMC displays the following:

- a “CLEARANCE COND NOT MET” scratchpad message.
- "CONDITION NOT MET" displayed in the 2L/2R line of the xxxxZ ATC UPLINK page.

Conditional clearances will be considered executed early when:

- the MCP altitude changes more than +/- 150 feet from the current altitude prior to satisfying the condition (time or position).
- an offset is executed including deleting an existing offset before the specified [time].

When the airplane satisfies the condition associated with a conditional clearance, a “clearance condition met” message displays the following:

- “CLEARANCE COND MET” scratchpad message.
- "CONDITION MET" displayed in the 2L/2R line of the xxxxZ ATC UPLINK page.

3 ATC INDEX

Displays the ATC INDEX page.

4 LOG

Displays the ATC LOG page 1/X.

Flight Management, Navigation — Chapter 11
FMC Preflight — Section 40

Introduction

Completion of the FMC preflight requires data entry in all minimum required data locations. Completing all required and optional preflight data entries ensures the most accurate performance possible.

Data link can be used to load preflight data from airline ground stations. Using data link reduces the required crew actions. Manual crew entries replace existing data. Data link can also be used to load takeoff data onto the TAKEOFF REF pages.

Preflight Page Sequence

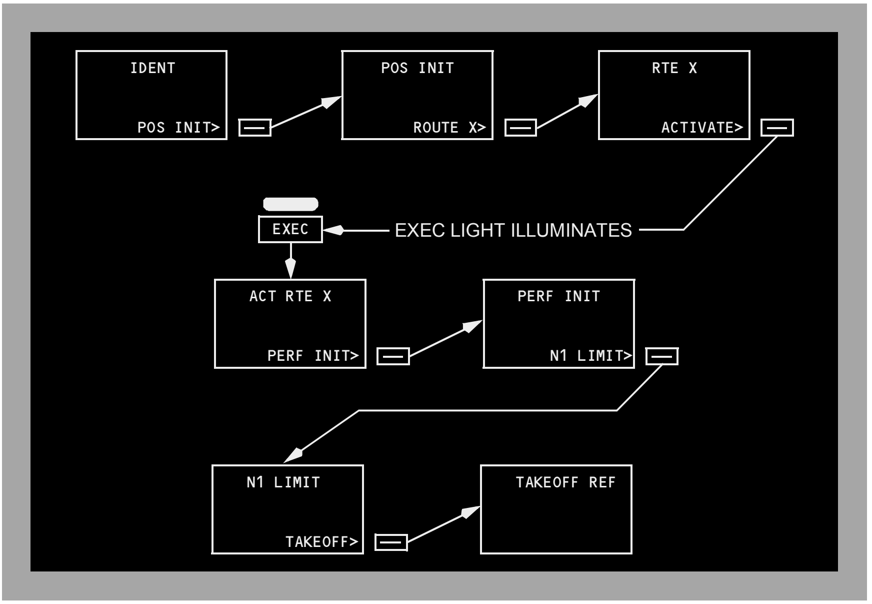
The normal preflight sequence follows paging prompts on each CDU page.

The normal FMC power–up page is the identification page. Preflight flow continues in this sequence:

- identification (IDENT) page
- position initialization (POS INIT) page
- route (RTE) page
- DEPARTURES page (no automatic prompt)
- performance initialization (PERF INIT) page
- N1 LIMIT page
- takeoff reference (TAKEOFF REF) page.

Some of these pages are also used in flight.

Minimum Preflight Sequence



During preflight, a prompt in the lower right of the CDU page automatically directs the crew through the minimum requirements for preflight completion. Pushing the prompt key for the next page in the flow presents new entry requirements. Additional entries are made on pages to refine the performance and route calculations. If a required entry is missed, a prompt on the TAKEOFF page leads the crew to the preflight page that is missing data.

The airplane inertial position is required for FMC preflight and flight instrument operation.

A route must be entered and activated. The minimum route information is origin and destination airports and a route leg.

Performance information requires the airplane weight and cruising altitude.

Supplementary Pages

Supplementary pages are sometimes required. These pages must be manually selected. Manual selection interrupts the normal automatic sequence. Discussions of each normal page include methods to display the page when the automatic sequence is interrupted.

When the route includes SIDs and STARs, they can be entered into the preflight using the DEPARTURES or ARRIVALS pages.

Route discontinuities are removed, the route is modified, and speed/altitude restrictions are entered on the RTE LEGS page. The RTE LEGS page is described in the FMC Takeoff and Climb and FMC Cruise sections of this chapter.

Waypoint, navigation, airport, and runway data is referenced on the REF NAV DATA page or the SUPP NAV DATA page. The REF NAV DATA page and SUPP NAV DATA page are described in the FMC Cruise section of this chapter.

VNAV performance is improved if the forecast winds and temperatures are entered during the preflight.

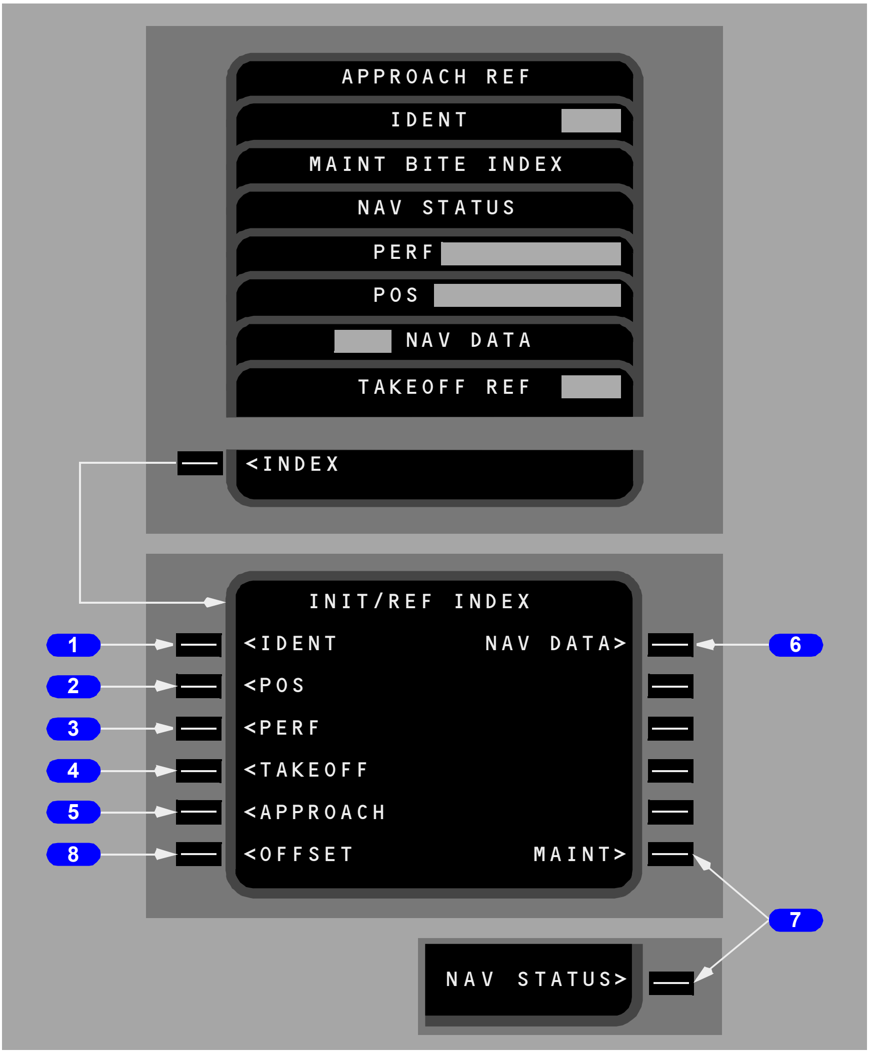
A single wind and temperature for cruise may be entered on the PERF INIT page. Wind and temperature data for specific cruise waypoints are entered on the RTE DATA page. The RTE DATA page is described in the FMC Cruise section. Wind and temperature for descent is entered on the DES FORECASTS page. The DES FORECASTS page is described in the FMC Descent section.

Preflight Pages

The preflight pages are presented in the sequence used during a typical preflight.

Initialization/Reference Index Page

The initialization/reference index page provides manual selection of FMC pages. It provides access to pages used during preflight and not normally used in flight.



1 IDENT

Push – displays the IDENT page, the first page in the automatic preflight sequence.

2 Position Initialization (POS)

- Push – displays the POS INIT page used for IRS initialization.
- POS INIT page is also used to enter/update magnetic heading for an IRS which is in the ATT mode.

3 Performance Initialization (PERF)

Push – displays the PERF INIT page for initialization of data required for VNAV operations and performance predictions.

4 Takeoff Reference (TAKEOFF)

Push – displays the TAKEOFF REF page to enter takeoff reference information and V speeds.

5 APPROACH

Push – displays the APPROACH REF page for entry of the approach VREF speed.

6 Navigation Data (NAV DATA)

Push – displays the REF NAV DATA page to display information about waypoints, navaids, airports, and runways. On the ground, displays the SUPP NAV DATA page if SUPP is entered in the scratchpad prior to selection.

7 Maintenance (MAINT) or Navigation Status (NAV STATUS)

- MAINT – On ground only.
  Push – displays maintenance pages for maintenance use.
- NAV STATUS – Replaces MAINT prompt when in air.
  Push – displays NAV STATUS page which shows status of navigation aids being tuned by the FMC. Replaces MAINT prompt when in air.

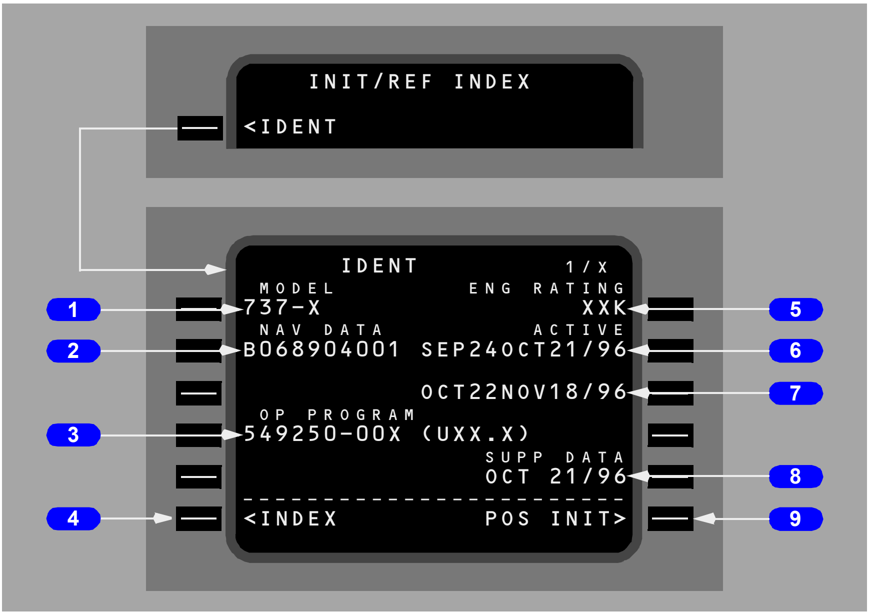
8 OFFSET

Push – displays the LATERAL OFFSET page for initiating a lateral offset.

Identification Page

Most of the data on this page is for crew verification. Active date accepts manual entries.

The crew verifies FMC data and selects a navigation database on the identification page.



1 MODEL

Displays the airplane model from the FMC performance database (e.g. 737–8 or 737-9).

Note: A model with a .1 appended to it indicates an airplane with a one-position tail skid (e.g. 737-8.1).

Note: A model with a .2 appended to it indicates an airplane with a two-position tail skid (e.g. 737-9.2).

2 Navigation Data (NAV DATA)

Displays the navigation database identifier.

3 Operational Program (OP PROGRAM)

Displays the Boeing software part number and update version. Update version installed at delivery:

- Update 13.0 (U13.0) or

- Update 14.1 (U14.1)

4 INDEX

Push – displays the INIT/REF INDEX page.

5 Engine Rating (ENG RATING)

Displays the engine thrust stored in the FMC performance database (e.g. 25K, 27K or 28K).

6 ACTIVE Date Range

Displays the effectivity date range for the active navigation database.

Database activation is accomplished by pushing the proper date range prompt to copy that date into the scratchpad. The scratchpad date may then be transferred to the ACTIVE database line. The previous active date moves down to the inactive date line.

The ACTIVE label appears above the active navigation database date. No label appears above the inactive navigation database date. The navigation database date can be changed only on the ground. Changing the navigation database removes all previously entered route data.

When an active database expires in flight, the expired database continues to be used until the active date is changed after landing.

7 Inactive Date Range

Displays the effectivity date range for the inactive navigation database.

8 Supplemental Data (SUPP DATA)

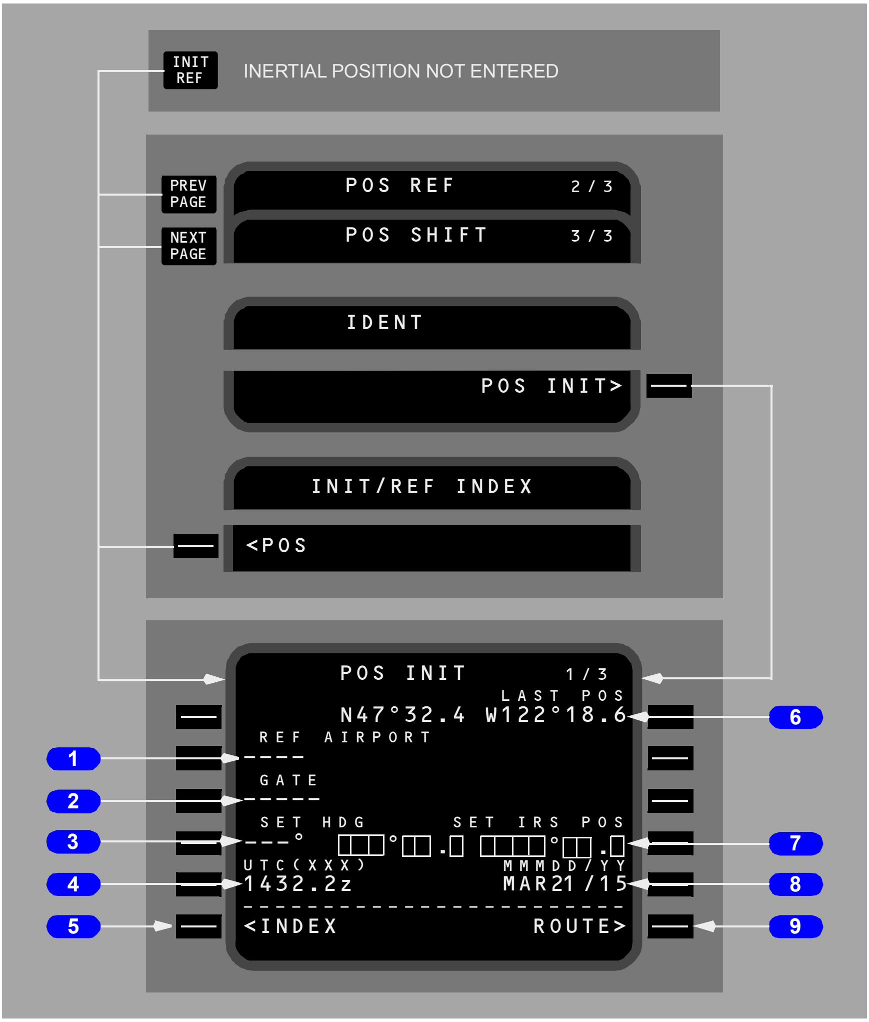
Displays the effective date of supplemental data. Blank if supplemental database is empty.

9 Position Initialization (POS INIT)

Push – displays the POS INIT page.

Position Initialization Page 1/3

The position initialization page 1/3 allows airplane present position entry for IRS alignment and FMC initialization. The same page is used to enter/update the magnetic heading for an IRS which is in the ATT mode. There are three POS pages.



1 Reference Airport (REF AIRPORT)

The reference airport entry allows entry of the current airport for display of the airport latitude/longitude.

Optional entry.

Valid entries are ICAO four letter airport identifiers.

Displays the latitude and longitude of the reference airport.

Removes previous GATE entry.

Entry blanks at lift–off.

2 GATE

The gate entry allows further refinement of the latitude/longitude position.

Optional entry after the reference airport is entered.

Valid entry is a gate number at the reference airport.

Displays the latitude and longitude of the reference airport gate from the navigation database.

Changes to dashes when a new reference airport is entered.

Entry blanks at lift–off.

3 Set IRS Heading (SET IRS HDG)

Enter/update magnetic heading for any IRS which is in ATT mode. Line blanks when IRS not in ATT mode.

4 UTC

Displays GPS time. If the GPS time is not valid, UTC starts at 0000.0Z when the FMC is first powered. Manually enter the correct UTC. If GPS time is not available, then entry of UTC time is required.

5 INDEX

Push – displays the INIT/REF INDEX page.

6 Last Position (LAST POS)

Displays the last FMC computed position.

7 Set IRS Position (SET IRS POS)

The set inertial position entry is required to initialize the IRS. Select the most accurate latitude/longitude for the initialization. A displayed latitude/longitude can be selected or a manual entry can be used.

If an entry is not made before the IRS finishes the initial alignment, the scratchpad message ENTER IRS POS is displayed.

Failure of the manually entered position to pass the IRS internal check displays the scratchpad message ENTER IRS POS.

Enter airplane position latitude and longitude.

Box prompts are displayed when either IRS is in the ALIGN mode and IRS present position has not been entered.

Blanks when the IRS transitions from the alignment to the navigation mode.

8 Date (MMMDD/YY)

Enter/update if blank or incorrect date is shown.

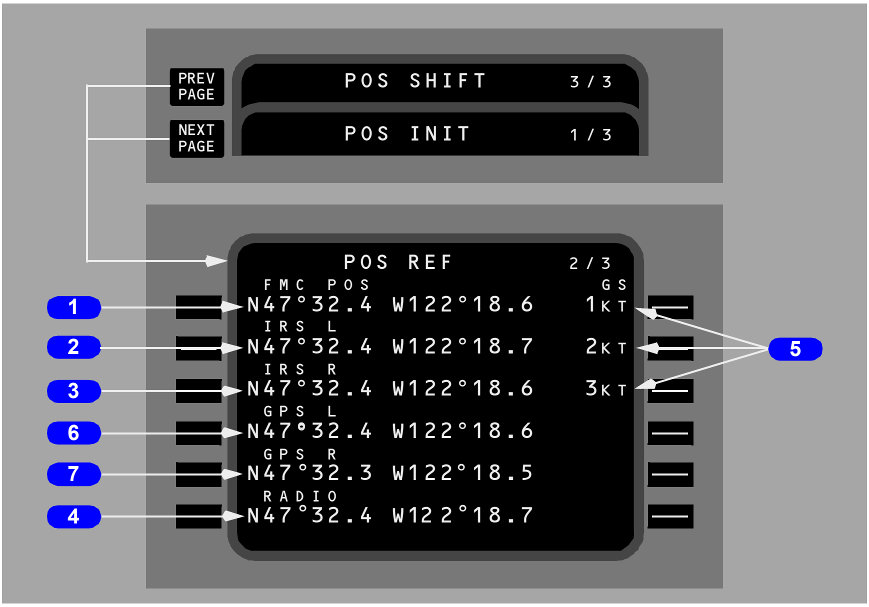
9 ROUTE

Push – displays the ROUTE page.

Position Reference Page 2/3

Position reference page 2 displays the airplane positions as calculated by the FMC, IRS, GPS, and radio navigation receivers.

This page displays latitude/longitude. All position displays are in actual latitude and longitude, as calculated by the respective system. Ground speed is displayed for the FMC and each IRS.



1 FMC Position (FMC POS)

Displays the FMC calculated latitude/longitude.

Blank if FMC position is invalid.

2 IRS L

Displays the latitude/longitude position as determined by the left IRS.

Blank if IRS position is invalid.

3 IRS R

Displays the latitude/longitude position as determined by the right IRS.

Blank if IRS position is invalid.

4 RADIO

Displays the latitude/longitude position as determined by the navigation radios.

Blank if on the ground or if radio position is invalid in flight.

5 Groundspeed (GS)

Displays the ground speed for FMC and IRS.

Blank if ground speed of related system is invalid.

6 GPS L

Displays the latitude/longitude position as determined by the left GPS.

Blank if GPS position is invalid.

7 GPS R

Displays the latitude/longitude position as determined by the right GPS.

Blank if GPS position is invalid.

Route Page 1/X

The route is entered and displayed in air traffic control format.

The first route page displays origin and destination data. Route segments are displayed on subsequent route pages.

Individual portions of the route may be manually entered by the flight crew. A pre–defined route may be loaded using the CO ROUTE line. CO ROUTE entries must correspond to a company defined route in the navigation database.

The route x (1 or 2) may also be uplinked.

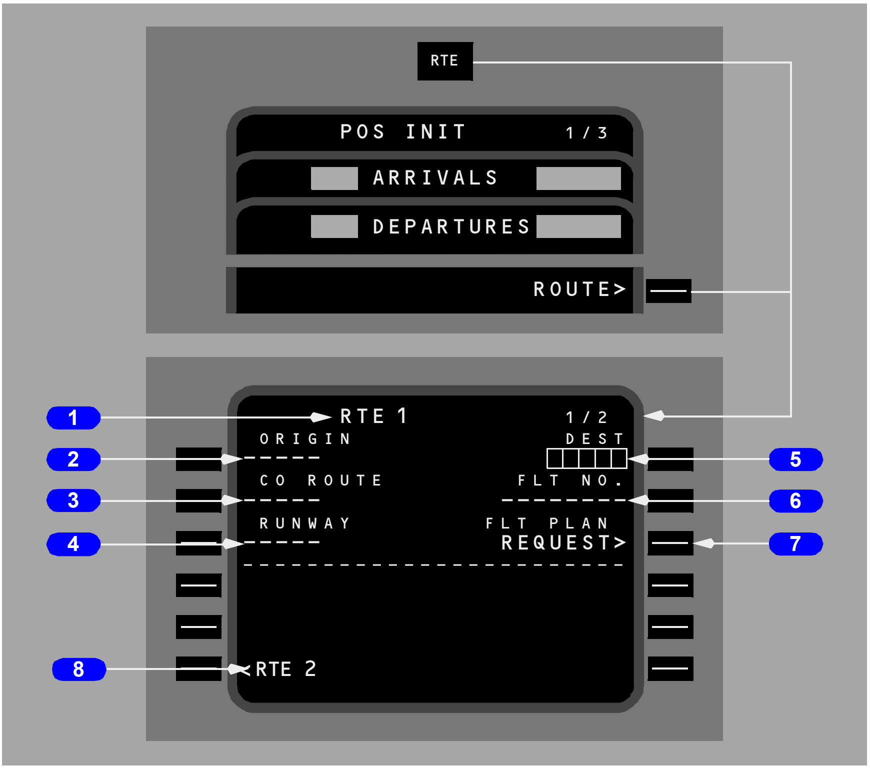
A route entered into RTE 2 allows the pilot to Activate, Predict and Erase a second route. The Active Route can be copied "COPY" into the second route "RTE 2". All flight planning capabilities, are available for the second route with the exception of Lateral Offsets and Direct To processing. Entering a departure runway can be done while in the air. The ERASE capability allows the crew to deactivate an activated plan. This allows the crew to use the second route as a "what if" predictor.

Messages that reference a route reflect the route to which they apply (i.e., PARTIAL ROUTE X LOADED).

The ACARS and FANS (as installed) functions include the second Route.

RTE 2 requires a separate set of Inactive Performance Data for "what if" predictions. This is accomplished by adding an inactive state to the Perf Init page when the Inactive Plan is activated. When an Inactive Plan becomes activated, the ACT PERF INIT is demoted back to an INACT PERF INIT page. Demoting means that the ACT will no longer be displayed in the title and ERASE for the ACTIVATED plan will be displayed in 6L.

Perf Init Data can be entered (and completed) at any time. The completed Perf Init data is not applied to any route until the route is ACTIVATED. Changes made to Perf Init data after the RTE is activated will be removed when the ACTIVATED route is ERASEd. If the ACTIVATED route is EXECd, the inactive Perf Init becomes part of the Active Route.



1 Page Title

The word ACT appears to the left of the title when the route has been activated and executed.

The word MOD appears to the left of the normal title when the route is modified and the change is not executed.

Multiple route pages are indicated by the page sequence number to the right of the title.

2 ORIGIN

Enter the ICAO airport identifier for the origin.

An entry is required for route activation.

Valid entries must be in the navigation database.

Entry is allowed for all phases of flight. Entry of a new origin erases the previous route.

New entries on an active route display MOD in the route title.

Enables direct selection of departure and arrival procedures for the origin airport.

Automatically entered as part of a company route.

3 Company Route (CO ROUTE)

A company route can be called from the navigation database by entering the route identifier. The data provided with a company route can include origin and destination airports, departure runway, SID, and STAR, and the route of flight. All company route data is automatically entered when the route identifier is entered.

An entry is optional for activation of the route.

Enter a company route identifier.

Valid entry is any crew entered company route name. If the name is not contained in the NAV database, the scratchpad message NOT IN DATA BASE is displayed.

Entry of a new company route replaces the previous route.

4 RUNWAY

Line title does not display until after entry of origin airport.

Enter the desired runway for the origin airport.

An entry is optional for activation of the route.

Entries must be in the navigation database.

New entries on an active route display MOD in the route title.

Can be entered from the DEPARTURES page.

Entry is deleted upon takeoff.

5 Destination (DEST)

Enter the ICAO airport identifier for the destination of the route.

An entry is required for route activation.

Entries must be in the navigation database.

New entries on an active route display MOD in the route title.

Enables direct selection of arrival procedures for the destination airport.

Automatically entered as part of a company route.

Entry and execution of a new destination clears any runway and runway dependent approach procedure of the previous destination. If the active leg is part of the affected procedure, then all subsequent (inactive) legs are cleared.

6 Flight Number (FLT NO.)

Enter the company flight number.

Entry is optional for activation of the route.

Limited to 8 characters.

Crew entered.

Flight number is included in the PROGRESS page title.

As installed:
Transponder transmits flight number to ATC.

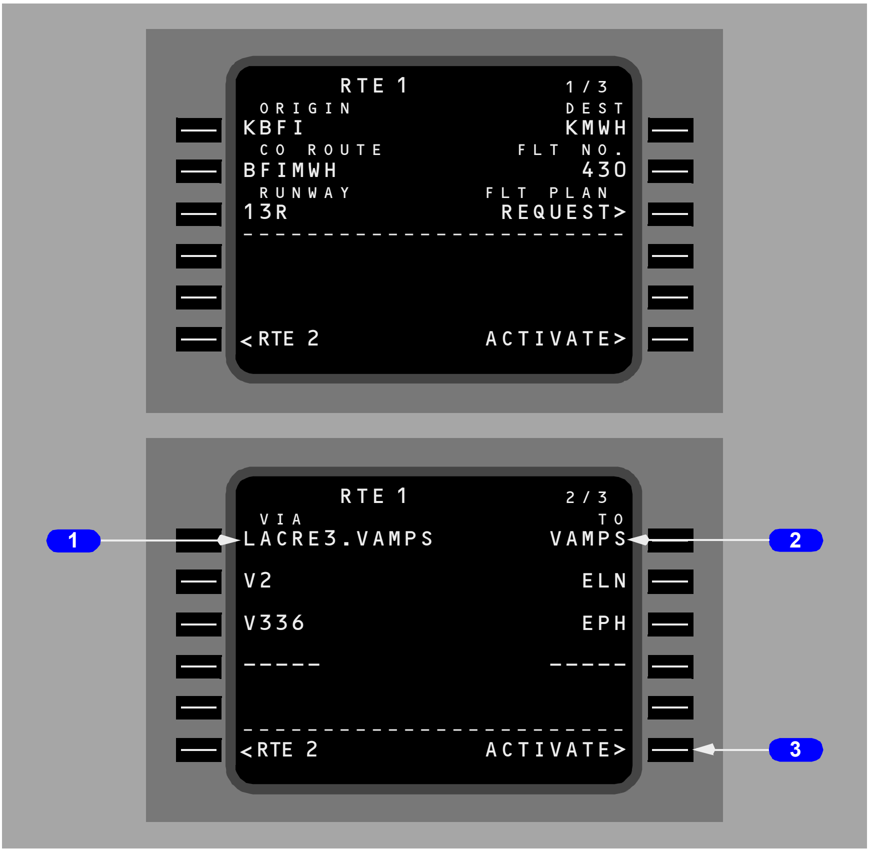
7 **FLT PLAN REQUEST**

Push – transmits a data link request for a flight plan route X uplink

8 **Route 1 or 2 (RTE X)**

Push - displays first or second route, depending on which route is currently being displayed at the Page Title position.

Route Pages 1/X and 2/X with Data Entries



1 VIA

The VIA column displays the route segment to the waypoint or termination displayed in the TO column. Enter the path which describes the route segment between the previous waypoint and the segment termination.

Enter an airway in the VIA column and box prompts are displayed in the TO column if the previous TO line contains a waypoint on the airway.

Valid entries can also include procedures or DIRECT. Procedures are normally entered through selections on DEPARTURES and ARRIVALS pages. DIRECT is normally entered as a result of entering a TO waypoint first.

Valid airways must:

- contain the fix entered in the TO waypoint, and
- contain the previous TO waypoint, or

Dashed prompts change to DIRECT if the TO waypoint is entered first.

Dash prompts appear for the first VIA beyond the end of the route.

Invalid VIA entries display the scratchpad entry INVALID ENTRY.

Invalid VIA entries are:

- airways and company routes which do not contain the TO waypoint of the previous line
- airways or company routes that are not in the navigation database.

When entering airways, the beginning and ending waypoints determine if the entry is valid. The route segment must contain the waypoint entered in the TO position. The TO waypoint of the previous route segment must be the same as the beginning point of the current route segment, or a route discontinuity is created between the segments.

Entry of a SID or transition automatically enters the VIA and TO data for the route segments of the SID. A SID automatically links to the next route segment when the final SID waypoint is part of the route segment.

LACRE3.VAMPS is an example of a SID selection made on the DEPARTURES page.

V2 is an example of airway entry.

2 TO

Enter the end point of the route segment specified by the VIA entry.

Entry of a waypoint in the TO column without first entering a VIA airway displays DIRECT in the VIA column.

Box prompts indicate that an entry is required.

Valid waypoint entries for a DIRECT route segment are any valid waypoint, fix, navaid, airport, or runway.

Valid waypoint entries for airways are waypoints or fixes on the airway.

Dash prompts appear on the first TO waypoint following the end of the route.

3 ACTIVATE

Pushing the ACTIVATE key arms RTE X for execution as the active route. When the EXEC key is pushed, RTE X becomes the active route and the ACTIVATE prompt is replaced with the next required preflight page prompt.

Push – prepares the selected route for execution as the active route.

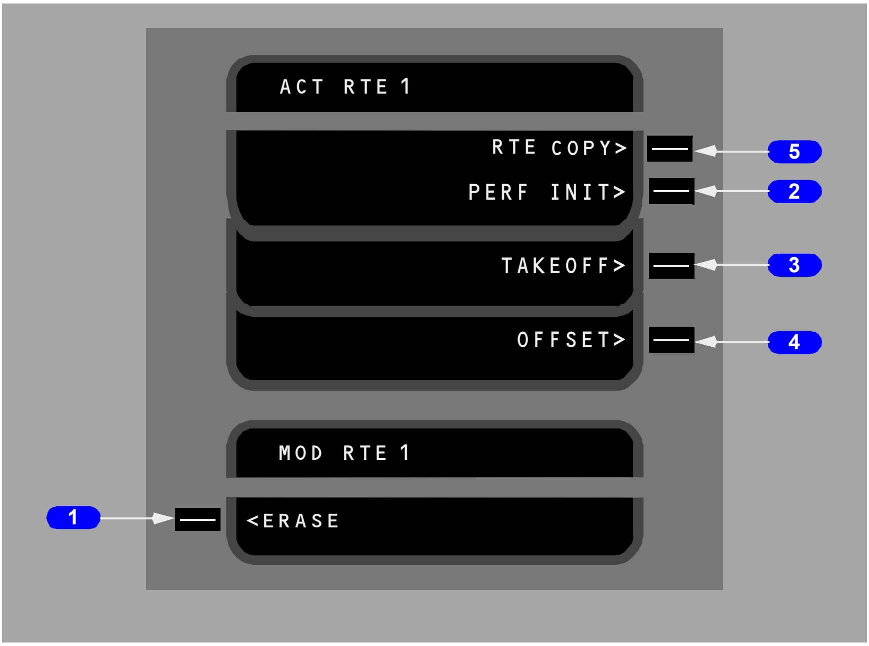
Execution of a route is required for completion of the preflight.

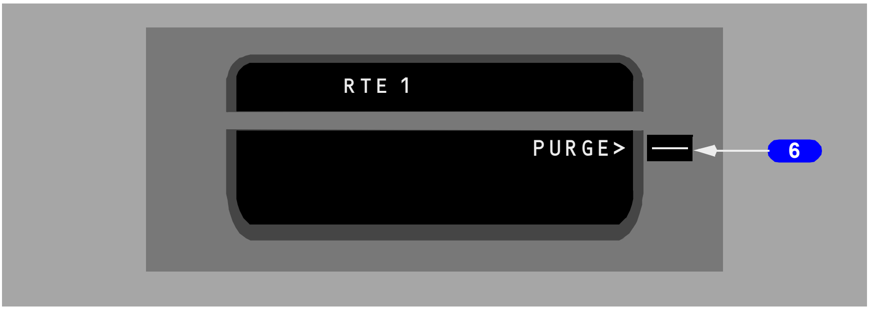
After RTE X activation the ACTIVATE prompt is blanked and the ERASE prompt replaces the RTE X prompt at LSK 6L.

After the EXEC key is selected the RTE COPY prompt becomes available at LSK 5R and LSK 6L displays the following prompts:

- PERF INIT, when the required performance data is incomplete, or
- TAKEOFF when the required performance data is complete.

Additional Route Page Prompts for an Activated Route





1 ERASE

Push – removes all pending modifications.

Displayed only during modifications.

2 Performance Initialization (PERF INIT)

Push – displays PERF INIT page.

Displayed only on the ground when required entries on the PERF INIT page are incomplete.

3 TAKEOFF

Push – displays TAKEOFF REF page 1/2.

Displayed only on the ground when all required entries on the PERF INIT page are complete.

4 OFFSET

Push – displays LATERAL OFFSET page.

Displayed only in flight.

5 Route Copy (RTE COPY)

Push – results in the active route being copied into the alternate route, regardless of scratchpad contents.

After selection of the RTE COPY> prompt, COMPLETE is displayed in the data field in large font and RTE COPY is displayed in the header field in small font.

RTE COPY in the header and COMPLETE is cleared upon re-entering the RTE Page and the DIR/INTC RTE LEGS page on both CDUs, execution/ERASE of a flight plan, or the other flight plan entering a pending activation state.

6 PURGE

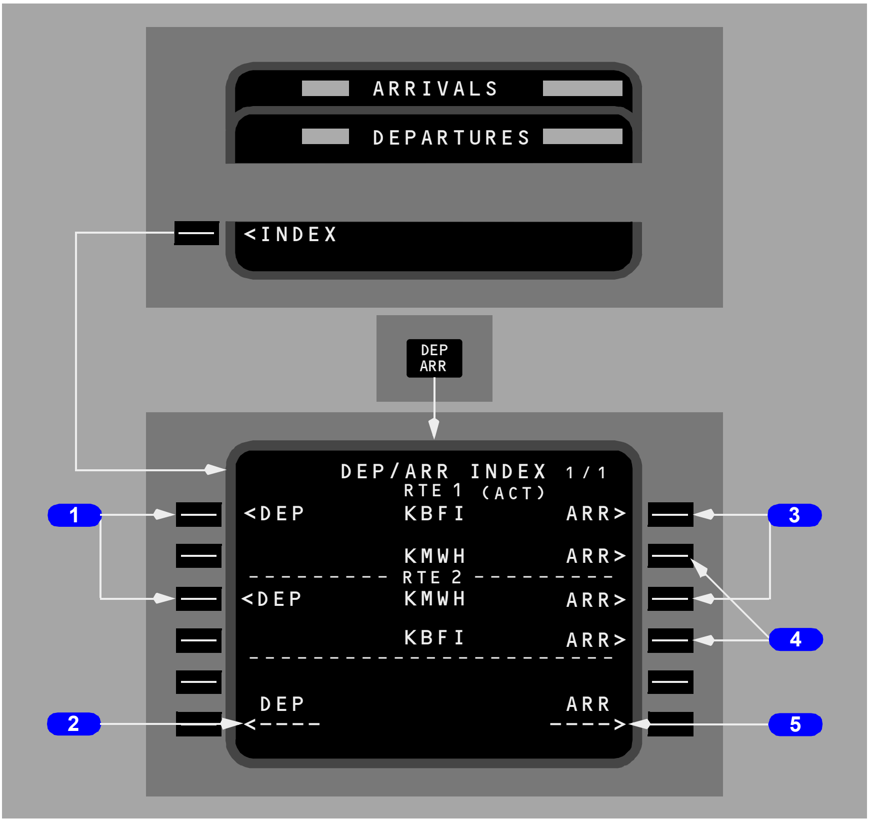
PURGE> is displayed in the data line in large font when the route displayed is inactive and a flight plan uplink load pending condition exists. If an inactive route becomes active, the purge prompt is removed from the new active route and is displayed on the new inactive route.

Push–results in the clearing of the route uplink, regardless of scratchpad contents.

Departure/Arrival Index Page

The departure and arrival index page is used to select the departure or arrival page for the origin and destination airports for each route. The index also allows reference to departure or arrival information for any other airport in the navigation database.

Departure and arrival prompts are available for the origin airport. Destination airports have only arrival prompts.



1 Departure (DEP) – Origin

Push – displays the departure page for Route 1 origin airport.

Push – displays the departure page for Route 2 origin airport.

2 Departure (DEP) – OTHER

Displays the departure page for the airport entered into this line through the scratchpad.

DEP prompt for OTHER allows display of departure information about airports that are not an origin or destination. The displayed information can be viewed but cannot be selected, because the airport is not on the route.

3 Arrival (APR) – Origin

Push – displays the arrival page for Route 1 or Route 2 origin airport. Origin airport arrivals selection is used during a turn–back situation.

4 Arrival (ARR) – Destination

Push – displays the arrival page for Route 1 or Route 2 destination airport.

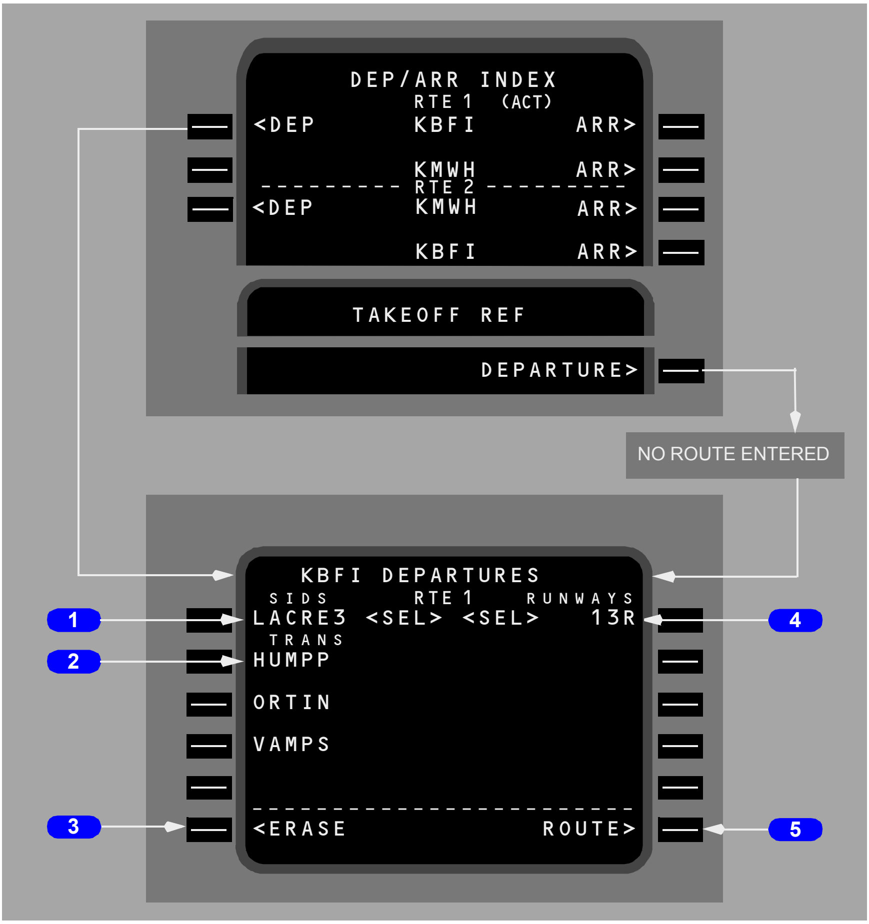
5 Arrival (ARR) – OTHER

Displays the arrival page for the airport entered into this line through the scratchpad.

ARR prompt for OTHER allows display of arrival information about airports that are not an origin or destination. The displayed information can be viewed but cannot be selected, because the airport is not on the route.

Departures Page

The departures page is used to select the departure runway, SID, and transition for the route origin airport.



1 Standard Instrument Departures (SIDS)

Displays SIDS for the airport and runway selections.

Displays the engine–out SIDS for the airport and runway selections following the last SID display line or on the first line if there are no SIDS for the departure airport and runway.

Without the selection of a runway on the RTE page, the initial display contains all of the information for the airport runways and SIDS. As selections are made, incompatible options are removed. SID transitions are displayed after a SID is selected.

2 **Transitions (TRANS)**

Displays transitions compatible with the selected SID.

3 **ERASE/INDEX**

ERASE is displayed when a route modification is pending.

Push – removes route modifications that are not executed and restores the original route.

INDEX is displayed when no route modification is pending.

Push – displays the DEP/ARR INDEX page.

4 **RUNWAYS**

Displays a list of runways for the selected airport.

The runway selected on the RTE page is displayed as <SEL> or <ACT> when this page is displayed.

5 **ROUTE**

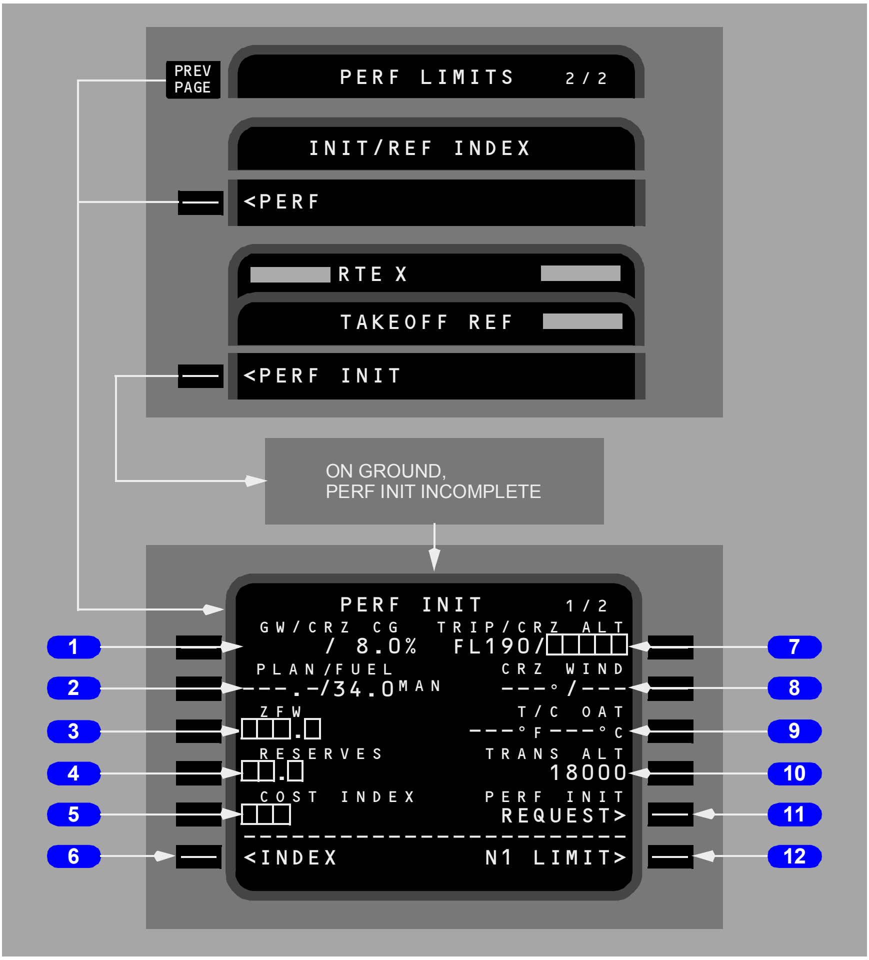
Push – displays the RTE page.

Selecting Options

Selecting an option displays <SEL> inboard of the option, and a route modification is created. When the modification is executed, the <SEL> becomes <ACT>. Leaving the page and returning displays all options and the <SEL> or <ACT> prompts.

Performance Initialization Page

The performance initialization page allows the entry of airplane and route data to initialize performance calculations. This information is required for VNAV calculations.



1 Gross Weight/Cruise Center of Gravity (GW/ CRZ CG)

Airplane gross weight entry is inhibited. Gross weight field is blank until zero fuel weight is entered.

Automatically displays calculated gross weight when zero fuel weight is entered.

Displays default or manually entered cruise CG. Entry of actual cruise CG may revise maximum altitude capability.

2 PLAN/FUEL (SENS, CALC, MAN)

PLAN entry facilitates pre-flight calculations of takeoff speeds and trip fuel predictions based on anticipated takeoff fuel load. Entries are deleted at engine start and are replaced by totalizer fuel quantity if valid or else by a manual fuel entry.

Displays the total fuel and indicates the source of the fuel being used for FMC calculations (also see FUEL MONITORING section 11.32):

- SENS – Totalizer value default or as selected by the crew on FUEL PROGRESS 5/5 page.
- CALC – FMC Calculated value as selected by the crew on the FUEL PROGRESS 5/5 page.
- MAN – Indicates a Manual pilot entry if CALCULATED is selected on PROGRESS 5/5 page.

3 Zero Fuel Weight (ZFW)

Airplane zero fuel weight is required. Normally the ZFW is entered from the airplane dispatch papers and the FMC calculates the airplane gross weight.

Enter the airplane zero fuel weight.

Valid entry is xxx or xxx.x.

Calculated zero fuel weight is automatically displayed if airplane gross weight is entered first and fuel on board is valid.

4 RESERVES

Enter fuel reserves for the route.

Entry is required to complete the preflight.

Valid entry is xx or xx.x.

5 COST INDEX

The cost index is used to calculate ECON climb and cruise speeds. The value reflects the relative impacts on overall trip cost of fuel cost as compared to other direct hourly operating costs.

Enter the cost index for ECON calculations.

Entry is required to enable use of VNAV mode.

Valid entries are 0 to 500. 0 causes the ECON speed to be MAX RANGE; 500 results in a minimum time flight.

Entry of a company route on RTE page causes any company stored value of cost index to be automatically displayed. A manual entry has priority.

6 **INDEX**

Push – displays the INIT/REF INDEX page.

7 **Trip/Cruise Altitude (TRIP/CRZ ALT)**

Trip altitude is automatically computed and displayed whenever entries have been made for the ORIGIN, DEST, GROSS WT, and COST INDEX. Otherwise, the field is blank.

Trip altitude is the predicted minimum cost altitude determined by operator constraints. Provides crew a reference for selecting a planned cruise altitude.

Cruise altitude is required.

Enter the cruise altitude for the route.

Automatically displays this cruise altitude on the CLB, CRZ, and RTE Legs pages.

8 **Cruise Wind (CRZ WIND)**

Cruise wind entry provides input to optimize FMC calculations.

Enter the forecast cruise wind.

Entry is propagated onto the RTE DATA page.

If no entry made, the FMC assumes zero wind for preflight predictions.

9 **Top of Climb Outside Air Temperature (T/C OAT)**

T/C OAT entry provides input to optimize FMC calculations.

Entry causes ISA DEV to be computed and displayed.

Enter top of climb OAT.

If no entry made, FMC assumes ISA value.

Note: The FMC takes advantage of sensed static air temperature (SAT) to automatically provide updating of the MAX altitude. The revised temperature model applies after climbing 5000 feet above the departure runway elevation. Calculation of MAX altitude uses the actual ISA deviation derived from the actual sensed SAT projected up to the MAX and OPT altitude solutions. T/C OAT, if entered on the PERF INIT page, is used for the preflight planning forecast of MAX/OPT altitude.

10 **Transition Altitude (TRANS ALT)**

Displays 18,000 feet at FMC power up.

Changes automatically when entering flight plan data based on the following criteria if a pilot entered value has not already been entered:

- the FMC will use the transition altitude from the NDB stored for the SID if the flight plan is active and a SID has been selected and a transition altitude exists for the SID.
- if an active flight plan exists and no transition altitude exists on the SID or a SID has not been selected, then the FMC will use the transition altitude from the NDB stored for the ORIGIN airport.
- if the transition altitude is not available from any of the sources above, then the FMC will default the transition altitude to 18000 feet or the value contained in a loaded custom performance defaults data base.

Manual entry has priority.

11 PERF INIT REQUEST

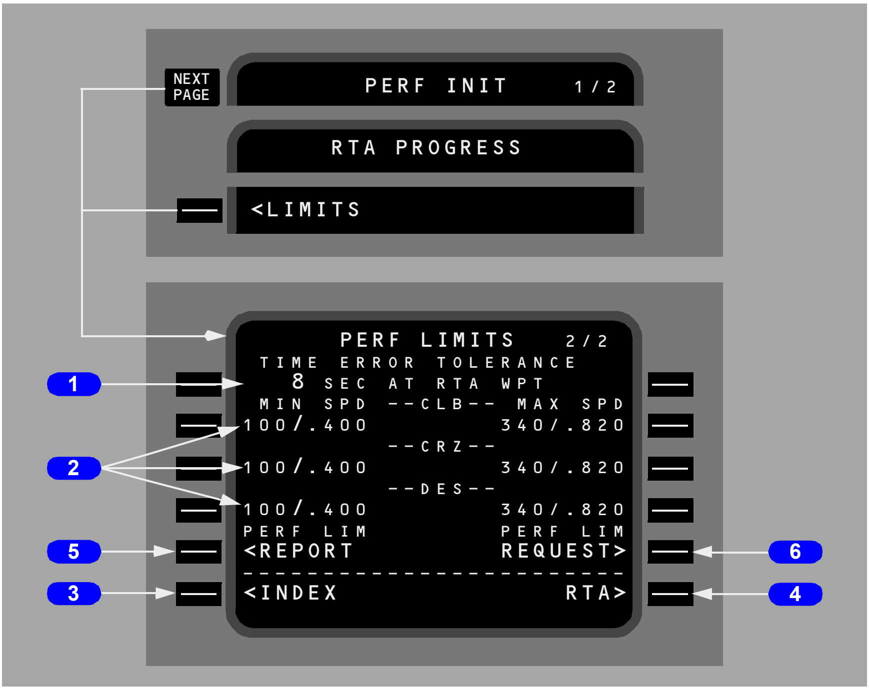
Push – transmits a data link request for a PERF INIT uplink

12 N1 LIMIT

Push – displays the N1 LIMIT page.

Performance Limits Page

The performance limits page allows the entry of performance limits affecting RTA and ECON calculations.



1 TIME ERROR TOLERANCE

Used during RTA calculations to establish a boundary on computed speeds.

Valid entry range is from 5 to 30 seconds.

Default value is 30 seconds and is displayed in small font.

2 Minimum Speed/Maximum Speed (MIN SPD/MAX SPD)

Establishes lower and upper speed limits for each phase of flight.

Default is 100/.400 for lower limit and 340/.820 for upper limit. Default values are displayed in small font and entered values are displayed in large font.

Either CAS or Mach can be entered.

Limits both RTA and ECON modes in flight.

3 INDEX

Push – selects INIT /REF INDEX page.

4 Required Time of Arrival (RTA)

Push – selects RTA PROGRESS page.

5 PERF LIM REPORT

Push – transmits displayed performance limits to ground station.

6 PERF LIM REQUEST

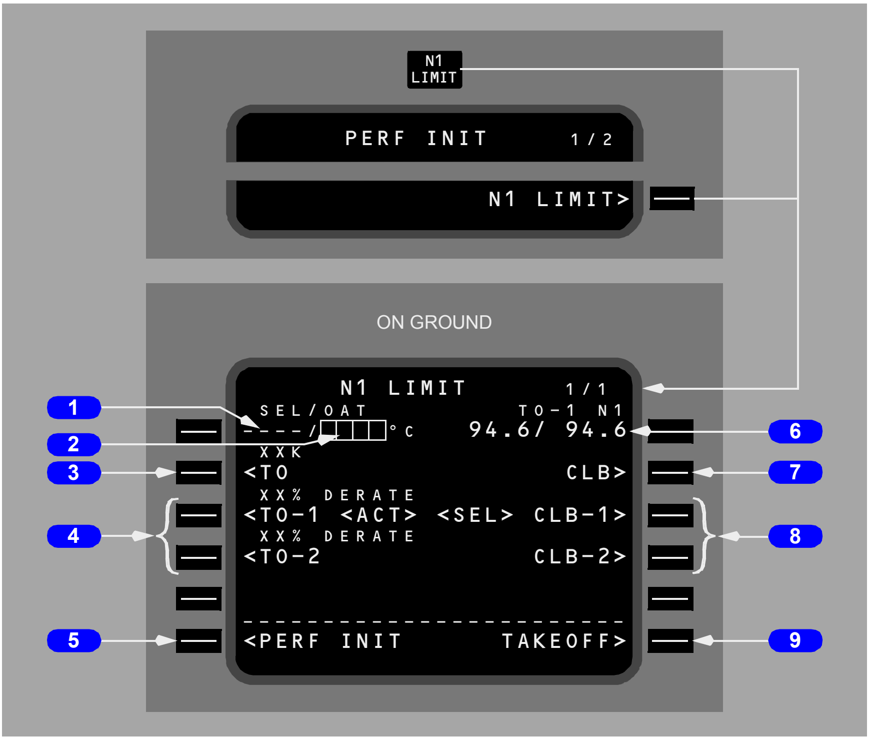
Push – transmits a data link request for a performance limits uplink.

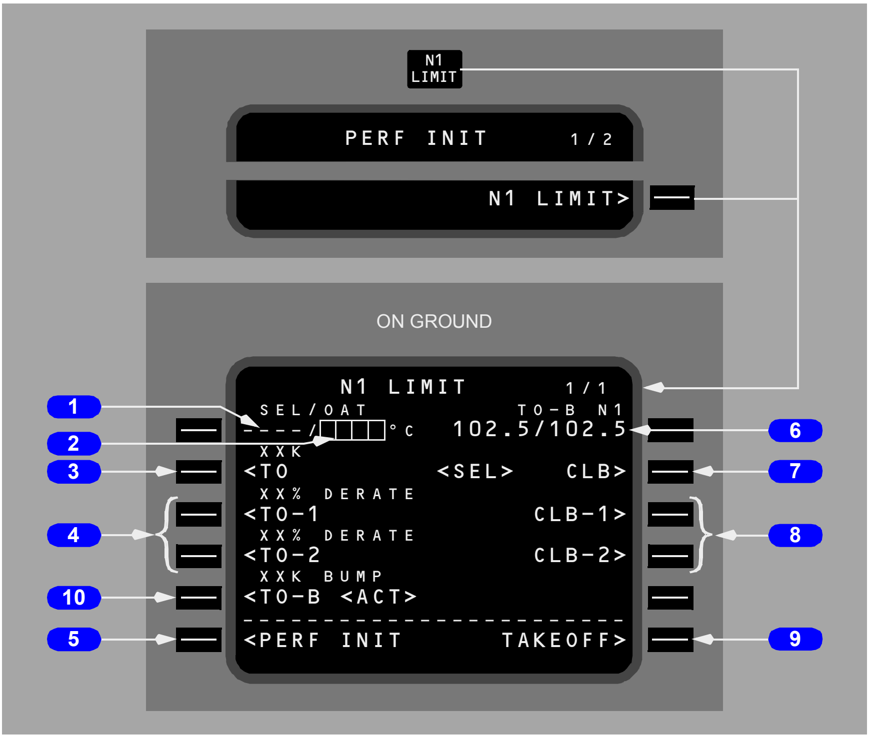
N1 LIMIT Page - Preflight

This section describes the preflight version of the N1 LIMIT page. See the FMC Takeoff and Climb section for a description of the in–flight version of the N1 LIMIT page.

The N1 LIMIT page is used during preflight to manage takeoff and climb thrust. Temperature data is entered, allowing the FMC to make N1 computations for normal or reduced thrust takeoff. Fixed takeoff and climb thrust derates may be selected.

The N1 LIMIT page is also used to select a takeoff bump (as installed) thrust setting to meet extra thrust requirements for takeoff at certain airports.





1 Selected Temperature (SEL)

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

Maximum allowable entry is 70 degrees C (158 degrees F).

Maximum allowed assumed temperature thrust reduction from TO-1 or TO-2 derated takeoff thrust is 25%.

2 Outside Air Temperature (OAT)

Manual entry of actual takeoff OAT is displayed in large–sized characters and is used by the FMC to calculate the takeoff N1 limits.

Entry can be made in degrees C or degrees F.

3 Takeoff Thrust Limit (TO XXK)

Push – selects full rated takeoff thrust limit.

Selection of TO automatically selects CLB thrust.

Data line title displays full rated thrust. Typical line titles display as “24K” or “26K.”

Selection of a new rating after V speeds are selected on the TAKEOFF REF page causes the V speeds to display in small font, and the NO VSPD flag to show on the airspeed indication.

4 Takeoff Derates (TO–1 and TO–2)

Push – selects the associated takeoff thrust limit.

Takeoff data uplink may automatically select a thrust derate.

The data line title displays the associated Percentage Takeoff Derates for reduced thrust ratings.

The default percent derates are set at 10% for TO-1 and 20% for TO-2.

Normally, selecting TO–1 automatically arms CLB–1 and selecting TO–2 automatically arms CLB–2.

Note: If a reduced thrust takeoff has been specified, then either CLB–1 or CLB–2 may be automatically specified if required to avoid a climb N1 value greater than the specified reduced thrust takeoff N1.

Selection of a new rating after V speeds are selected on the TAKEOFF REF page causes the V speeds to display in small font, and the NO VSPD flag to show on the airspeed indication.

5 PERF INIT

Push – displays the PERF INIT page.

6 Takeoff N1

Displays the FMC computed N1 for takeoff

Data line title displays full rated thrust or selected takeoff derate thrust. Typical line titles display as “TO N1” or “TO-1 N1” or “TO-2 N1”.

Data line title changes to RED TO N1 when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. If a SEL TEMP and a DERATE are both selected the data line title will change to “RED TO-X N1,” and the effect on thrust will be additive.

Data line title changes to TO-B N1 when takeoff bump (as installed) thrust is selected.

7 Climb (CLB)

Push – selects full rated climb thrust limit.

Climb thrust is automatically selected at the thrust reduction point on the TAKEOFF REF page 2.

8 **Reduced Climb (CLB–1 and CLB–2)**

Push – selects the associated reduced thrust climb mode.

CLB–1 provides a climb limit reduced by 3% N1 (approximately 10% thrust). CLB–2 provides a climb limit reduced by 6% N1 (approximately 20% thrust).

Deletion results in the selection of CLB thrust.

Manual selection of a climb thrust rating overrides the automatic selection.

Takeoff data uplink may automatically select a thrust derate.

9 **TAKEOFF**

Push – displays the TAKEOFF REF page.

10 **Takeoff Bump Thrust (TO–B)**

Push – selects takeoff bump thrust limit

Selection of TO–B automatically selects CLB thrust.

Data line title displays takeoff bump thrust. Typical line titles display as "26K BUMP" or "28K BUMP."

When takeoff bump thrust is selected, assumed temperature (SEL temperature) thrust reduction is not available.

Takeoff data uplink may automatically select takeoff bump thrust.

Selecting Takeoff Thrust

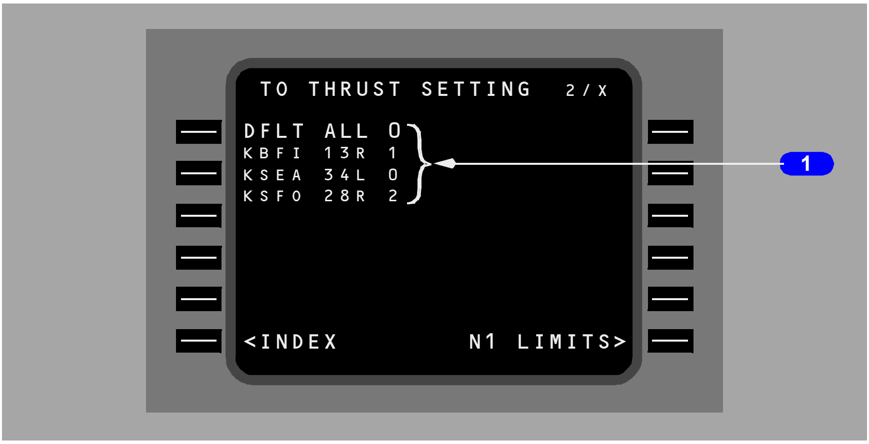
Selecting the takeoff thrust displays <ACT> inboard of the selection. The FMC automatically selects the highest climb thrust available (CLB, CLB-1, CLB-2) which would not result in a thrust lever push, when the aircraft transitions from takeoff to climb. <SEL> is displayed inboard of the selected climb N1 limit.

Takeoff Thrust Auto Selection

The Takeoff Thrust Auto Selection option provides a baseline thrust that is automatically selected for specific airport locations and runways. The FMC can auto–select an appropriate takeoff thrust rating based on airline policy and flight crew entered airport/runway for the active flight plan.

The display list of airport/runway/thrust records stored in the FMC is accessible via selecting NEXT PAGE on the N1 LIMITS page.

Additionally, a CDU message, VERIFY TAKEOFF THRUST, will be displayed in the event of a TO thrust conflict, such as an FMC selected rating not being compatible with the actual engine/airframe.



1 Thrust Ratings

Thrust Ratings stored in the FMC are identified as:

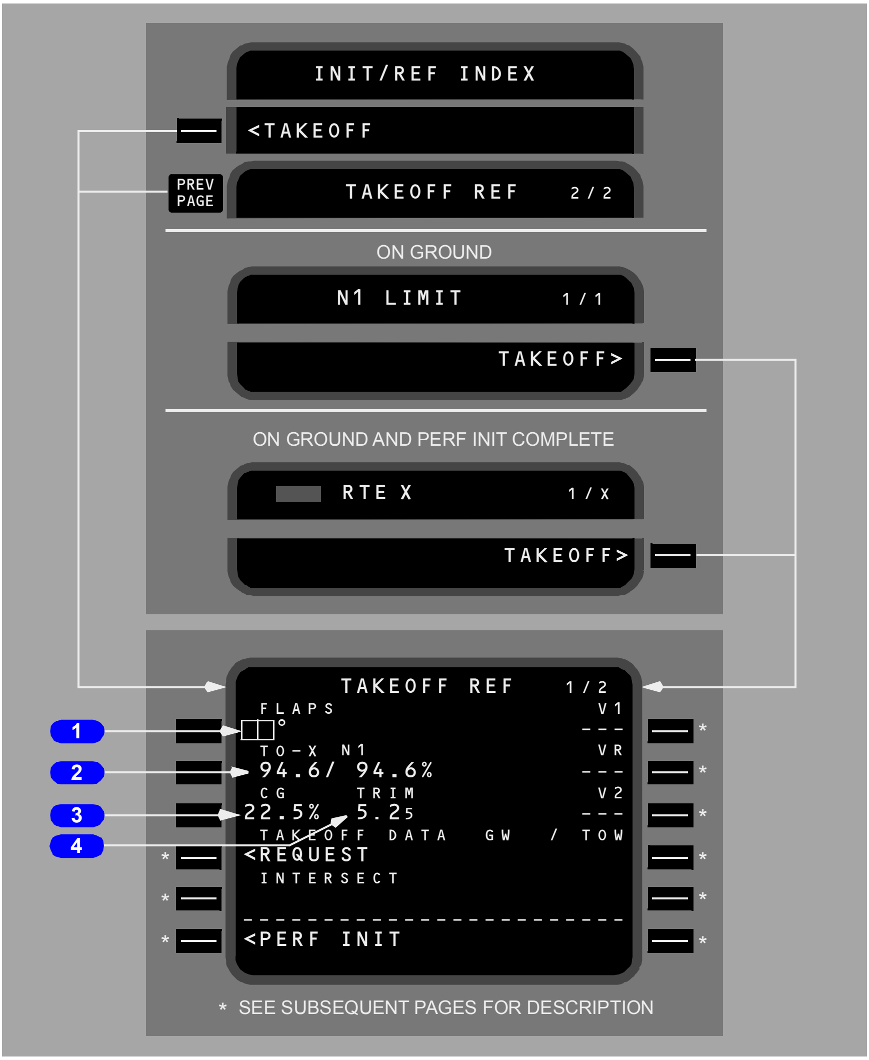
- 0 – full
- 1 – fixed takeoff derate
- 2 – fixed takeoff derate (if available for current FMC/engine configuration)
- B – takeoff bump (if available for current FMC/engine configuration).

Takeoff Reference Page 1/2

The takeoff reference page allows the crew to manage takeoff performance.

Takeoff flap setting and V speeds are entered and verified. Thrust limits, takeoff position, CG, and trim can be verified or changed.

Preflight pages are selectively displayed to indicate preflight status whenever required entries on those pages are incomplete. Takeoff reference page entries finish the normal preflight. V speeds should be set before completion. FMC position can be updated prior to takeoff.



1 FLAPS

Enter takeoff flaps setting. Manual entry of 1, 5, 10, 15, or 25 allowed.

2 Takeoff N1

Displays the FMC computed N1 for takeoff

Data line title displays full rated thrust or selected takeoff derate thrust. Typical line titles display as “TO N1” or “TO-1 N1” or “TO-2 N1”.

Data line title changes to RED TO N1 when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. If a SEL TEMP and a DERATE are both selected the data line title will change to "RED TO-X N1," and the effect on thrust will be additive.

Data line title changes to TO-B N1 when takeoff bump thrust is selected.

3 Center of Gravity (CG)

Initial display is dashes.

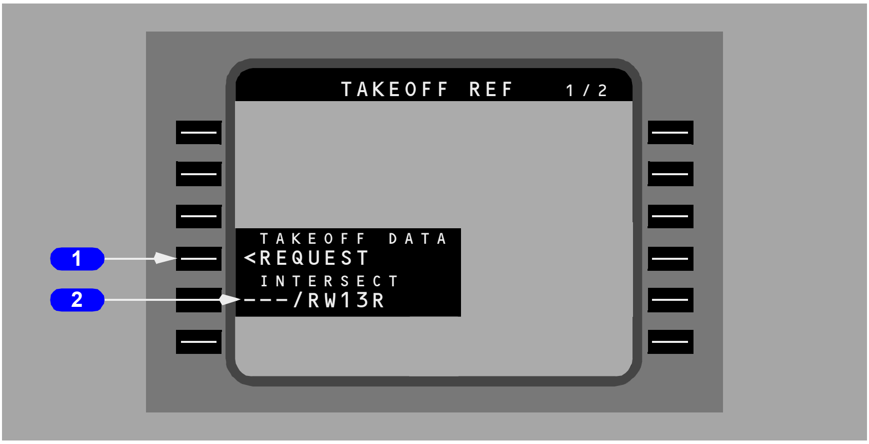
After CG is entered, the FMC calculates and displays stabilizer takeoff trim settings.

4 TRIM

Displays stabilizer takeoff trim setting.

Display is blank unless FLAPS and CG are entered.

Company Data Link



1 TAKEOFF DATA REQUEST

Push – transmits a data link request for a takeoff data uplink. Resulting TAKEOFF REF uplink may contain takeoff data for up to 6 runways, which are stored in FMC uplink memory.

2 Intersection (INTERSECT)

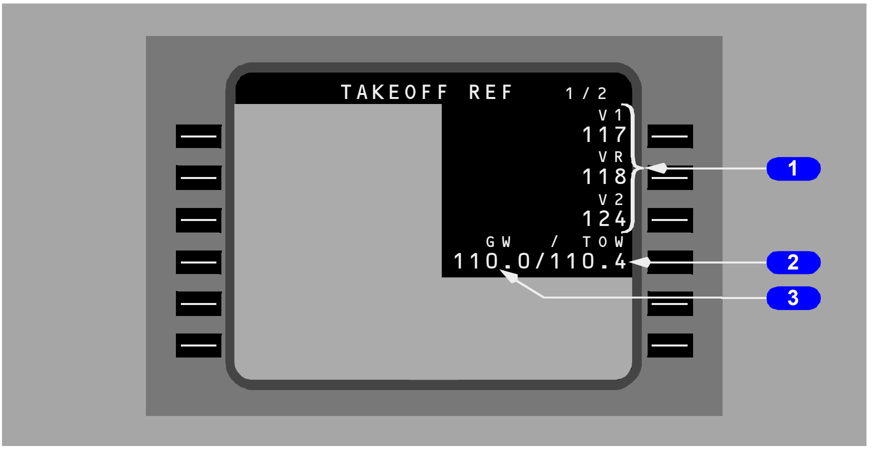
Displays active runway.

An intersection may be entered. Valid entries are 1 to 3 alphanumerics.

If an intersection is entered and TAKEOFF DATA REQUEST is made, the runway/intersection pair is included in the request downlink.

If the displayed runway or runway/intersection pair matches a runway or runway/intersection pair in FMC uplink memory, the associated TAKEOFF REF UPLINK is annunciated for flight crew ACCEPT/REJECT.

V Speed Data



1 V Speeds (V1, VR, and V2)

Crew calculated V speeds may be entered and displayed for reference.

V speeds may be uplinked.

Large font V speeds are displayed on the airspeed indication.

2 Takeoff Weight (TOW)

Displays gross weight the uplink V speeds are based on.

Blank if there are no uplinked V speeds in the column above.

3 Gross Weight (GW)

Displays current gross weight.

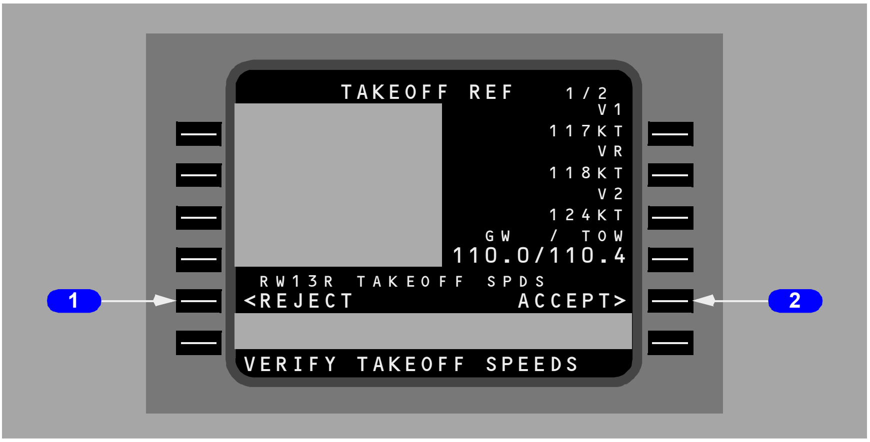
Change of Performance Data After V Speed Entry

V speeds should be entered on the TAKEOFF REF page as a final step of FMC preflight. If V speeds are entered and then performance data (for example, OAT or takeoff thrust) is subsequently changed, the FMC automatically removes the previously entered V speeds and the NO VSPD flag shows on the airspeed indication.

In addition, the scratchpad message VERIFY TAKEOFF SPEEDS displays if any of the following items are changed after V speeds have been entered:

- gross weight
- zero fuel weight
- plan fuel.

The previously entered V speeds are displayed in small font on the TAKEOFF REF page.



1 REJECT

Displayed if V speeds have been entered and airplane gross weight, ZFW, or plan fuel has been changed.

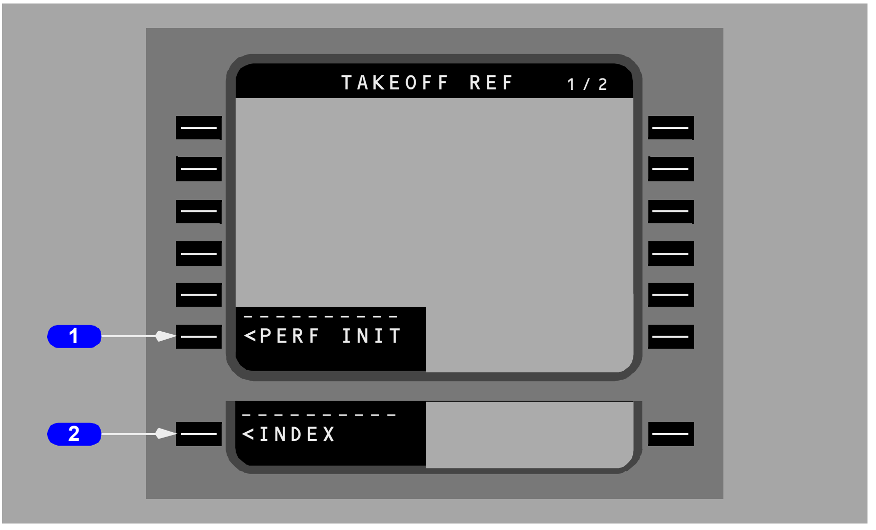
Push – causes the now small font takeoff speeds to disappear.

2 ACCEPT

Displayed if V speeds have been entered and airplane gross weight, ZFW, or plan fuel has been changed.

Push – changes the small font takeoff speeds to large font.

Preflight Status



1 Preflight Incomplete

When required preflight entries are not complete, the related page title displays

- POS INIT – IRS position not entered or invalid
- PERF INIT – required performance data not entered or executed
- ROUTE – required RTE page data not entered
- DEPARTURE – runway or route data not entered on the RTE page.
- N1 LIMIT – OAT not entered.

Push – Displays associated page.

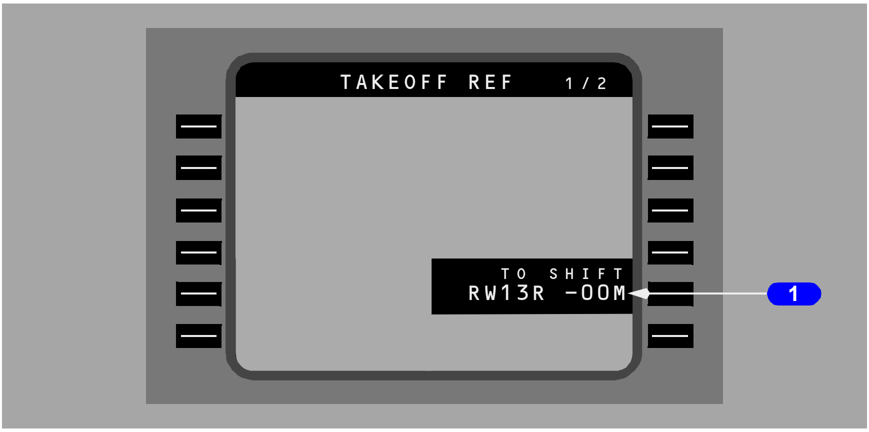
2 Preflight Complete (INDEX)

When the required preflight entries are complete, the index prompt is displayed below the takeoff reference page data. When required preflight entries are not complete, the related page title replaces the INDEX prompt.

Displayed following completion of required preflight entries on the POS INIT, RTE, and PERF INIT pages.

Push – Displays INIT REF INDEX page.

FMC Takeoff Position Update



1 Takeoff Shift (TO SHIFT)

Automatically displays the departure runway from the route page.

If a takeoff shift distance is not entered and GPS UPDATE is OFF, the FMC updates to the runway threshold when TO/GA is pushed.

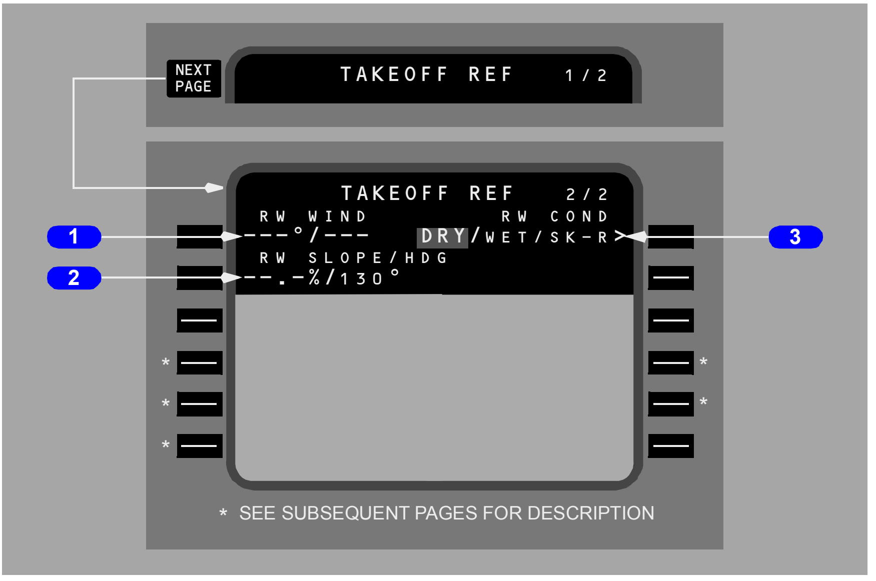
If a takeoff shift distance is entered and GPS UPDATE is OFF, the FMC updates to the threshold of the departure runway plus the entered distance when the TO/GA switch is pushed.

TO/GA position update inhibited if GPS UPDATE is ON.

Following TO/GA update, the runway identifier and any entered shift value are highlighted in reverse video characters.

To remove a TO SHIFT entry, reselect RWY on the RTE page.

Takeoff Reference Page 2/2



1 Runway Wind (RW WIND)

Enter surface wind direction and speed.

Entry is optional for preflight completion.

2 Runway Slope/Heading (RW SLOPE/HDG)

Enter runway slope.

Entry is optional for preflight completion.

Valid runway slope is U or + for up or D or – for down followed by slope in percent gradient.

HDG displays runway heading for origin airport.

3 Runway Condition (RWY COND)

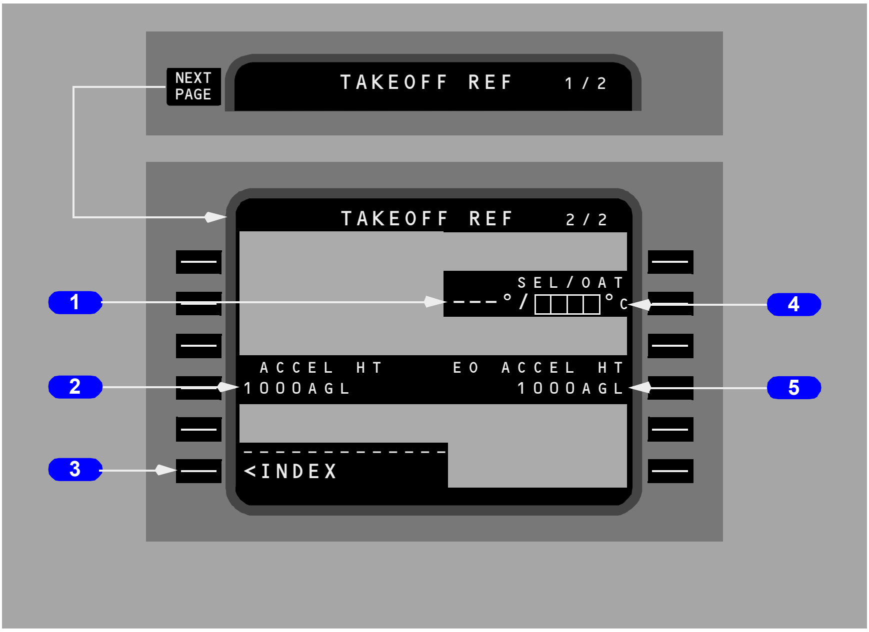
Active runway condition is highlighted:

- DRY – Dry runway computations
- WET – Wet runway computations
- SK–R – Skid resistant runway computations

Default condition is DRY.

The runway condition can be viewed by flight crew and shows under what conditions the uplinked V Speeds have been computed for. The runway condition is displayed for reference only and cannot be changed by the flight crew.

Takeoff Thrust



1 Selected Temperature (SEL)

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

Maximum allowable entry is 70 degrees C (158 degrees F). The FMC, however, will limit the N1 to 25% takeoff reduction.

Repeats data shown on the preflight version of the N1 LIMIT page.

2 Acceleration Height (ACCEL HT)

Displays acceleration height altitude above origin airport elevation for flap retraction.

Default value is from the airline.

Entry is optional. Value is a height from 400 to 9999 feet.

3 INDEX

Push – displays the INIT/REF INDEX page.

4 Outside Air Temperature (OAT)

Manual entry of actual takeoff OAT is used by the FMC to calculate the takeoff N1 limits.

Entry can be made in degrees C or degrees F.

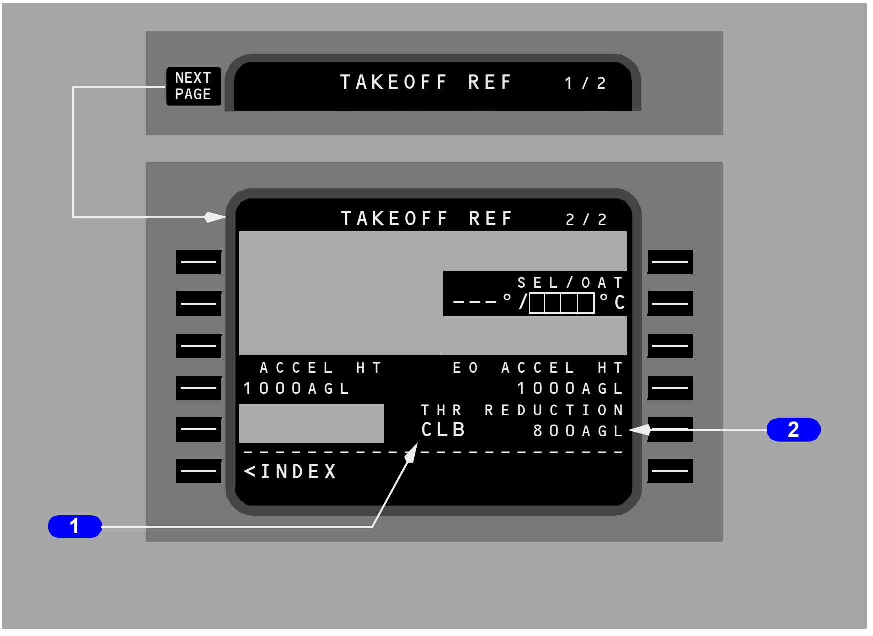
5 Engine Out Acceleration Height (EO ACCEL HT)

Displays acceleration height altitude above origin airport elevation for flap retraction with an engine out.

Default value is from the airline.

Entry is optional. Value is a height from 400 to 9999 feet.

Automatic Thrust Reduction



1 Selected Climb Rating

Displays the climb rating that will be set at the THR REDUCTION altitude, as selected on the preflight version of the N1 LIMIT page.

2 Thrust Reduction (THR REDUCTION)

Altitude above origin airport elevation at which the autothrottle reduces from takeoff N1 to climb N1.

The default value is determined by the airline and is stored in the model/engine database. The default is displayed in small font.

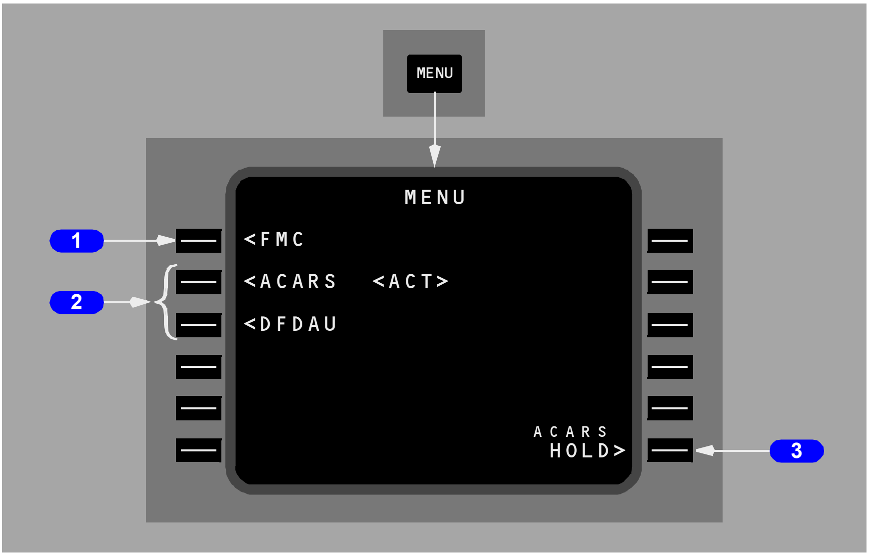
Manual entries allowed on the ground. Entries must be between 800 to 9,999 feet and are displayed in large font.

Deletion of a manual entry returns the display to the default value.

Menu Page

The menu page is selected with the MENU key or is automatically displayed when the currently active subsystem fails or on initial power up if the FMC system is not detected.

The menu page displays subsystems (ACARS, DFDAU, etc.) that require control/display functions through the MCDU and provides a means to temporarily access to these subsystems. The active system is indicated by <ACT> displayed next to the system title. A subsystem that requires use of the CDU displays a request message <REQ> next to the subsystem title. The FMC system or a requesting subsystem is accessed by using the line select key next to the title. The FMC can be reselected by selecting the FMC prompt on the MENU page or selecting any mode key (INIT/REF, RTE, etc.). A subsystem can be temporarily placed on hold <HLD> by selecting the subsystem XXXXXX HOLD> line select key returning the CDU display to the currently active FMC page (XXXXXX represents the system name). While the subsystem is on hold the MCDU CALL light is illuminated. To reselect the subsystem on hold, push the subsystem line select key again. When a subsystem is placed on hold a XXXXXX LOGOFF prompt appears to allow for release of the subsystem being held. No more than one subsystem can be selected at a time. If an attempt is made to select more than one subsystem, a FIRST LOGOFF XXXXXX prompt is displayed as a reminder to logoff the currently active subsystem.



1 FMC

Push – selects FMC as the system for which the MCDU will be active in providing control/display function.

2 Other Aircraft Subsystems (typical)

Push – selects the subsystem for which the MCDU will be active in providing control/display function.

3 XXXXXX HOLD/LOGOFF

Push - places active subsystem on hold or logs off subsystem and returns control to the FMC.

Flight Management, Navigation — Chapter 11
FMC Takeoff and Climb — Section 41

Introduction

The FMC takeoff phase begins with the selection of takeoff/go–around (TO/GA). Preparation for this phase begins in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase automatically changes to the climb phase when climb thrust is selected. The climb phase continues to the top of climb point, where the cruise phase begins.

During these phases, the following pages are normally used:

- TAKEOFF REF page – to make last minute changes to the departure runway
- DEPARTURES page – to make last minute changes to the SID
- CLIMB page – to modify climb parameters and monitor airplane climb performance
- RTE LEGS page – to modify the route and monitor route progress
- PROGRESS page – to monitor the overall progress of the flight
- N1 LIMIT page – to select alternate climb thrust limits
- DEP/ARR INDEX page – to select an approach during a turn–back.

Takeoff Phase

When last minute changes are made to the departure runway and SID, the TAKEOFF REF and DEPARTURES pages must be modified to agree. The modifications are performed the same as during preflight.

With correct takeoff parameters, the FMC commands the selected takeoff thrust when the TO/GA switch is pushed. During the takeoff roll, the autothrottle commands the thrust and the FMC commands acceleration to between V2+15 and V2+25 knots.

LNAV can be armed prior to takeoff. Prior to 50 feet radio altitude, roll command is wings level. At 50 feet radio altitude, if within engagement criteria, LNAV engages and provides roll commands to fly the route leg. VNAV may be engaged to control the climb profile.

Note: For LNAV to be armed on the ground, the departure runway must be selected and the course, to the first waypoint, must be within 5 degrees of the runway heading.

VNAV Armed for Takeoff

VNAV may be armed on the MCP prior to takeoff provided the following requirements have been met:

- a valid flight plan has been entered
- performance data has been entered and executed
- both flight director switches have been switched on

Target Speeds will follow the profile listed in the Climb Phase.

The MDS will annunciate VNAV armed on the FMA when VNAV is selected prior to takeoff and it is capable of being armed. On takeoff and after reaching 400 feet above the runway, the FCC will automatically engage VNAV if armed.

VNAV Takeoff -One Engine Out

During the all engine takeoff flight phase, VNAV will be enabled to automatically adjust the target airspeed profile upon engine out detection.

If a single engine failure is detected while in the VNAV takeoff flight phase (for all engines) and below the engine out takeoff acceleration height, the FMC will calculate and issue a target speed equal to the greater of current airspeed or V2 limited to be less than or equal to V2 + 20 KCAS.

This speed will continue to be updated until an engine failure is detected, at which point the target speed will be frozen at the present value.

VNAV will continue to generate this target speed until reaching the engine out acceleration height or when VNAV guidance initiates a level-off prior to reaching the engine out acceleration height, at which point the VNAV target speed will be changed to VREF + 70 KCAS (flaps up maneuver speed) subject to the applicable speed limits for the current airplane configuration.

VNAV will continue to issue the VREF + 70 KCAS target speed through flap retraction and thrust reduction, and retains this target for obstacle clearance until the pilot selects and executes the ALL ENG prompt on the CDU or VNAV transitions to the cruise flight phase to complete the engine-out takeoff flight phase.

The FMC engine-out mode will not be set when the groundspeed is less than 60 knots. If the engine-out mode is set while on the ground, the FMC will exit the mode when the speed drops below 60 knots. Engine-out speeds will be available if an engine fails on takeoff after 60 knots.

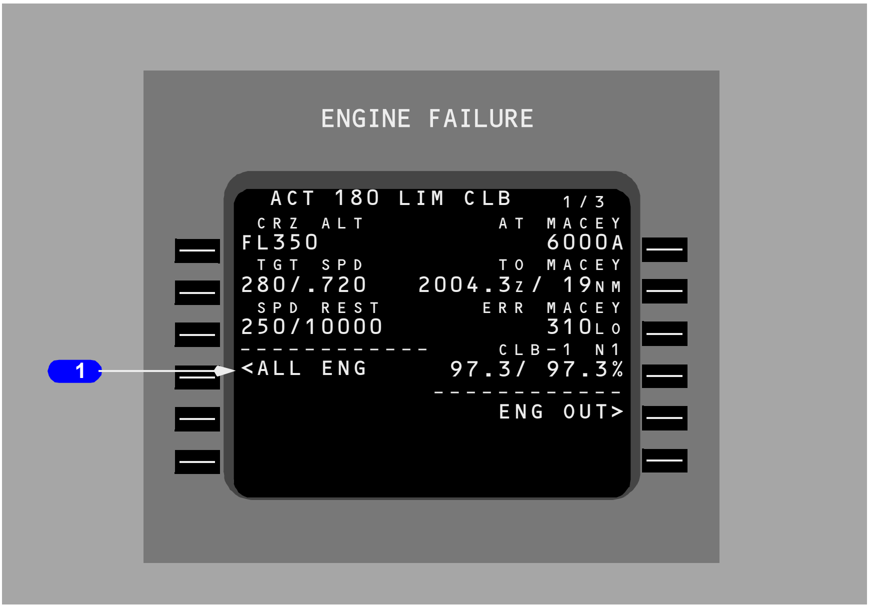
Prediction displays will be blanked on the MCDU pages when engine failure is detected and airspeed is over 60 knots of ground speed. Route (RTE) data, estimated time of arrival (ETA) data and top of climb (TOC) data displayed on the MDS Navigation Display will be blanked when an engine-out condition has been detected by the FMC. Engine-out will be cleared and the target speed and predictions will return to normal two engine values when the crew selects and EXECutes the ALL ENGINE prompt on the CLB page, or the CRZ or DES phase is entered, or a Flight Complete occurs, regardless of how many engines are running.

A new FMC CDU message (ENTER EO CRZ SPD AND ALT) will be displayed when the engine-out operation is terminated due to reaching cruise altitude or the pilot depresses the ALL ENGINE prompt button on the climb page.

When an engine failure has been detected, the thrust reduction height and the all engine acceleration height specified on TAKEOFF REF page two will be ignored. All waypoint fuel, ETA, Progress page and LEGS page performance predictions will be blanked. Upon exiting the engine out takeoff flight phase, the performance predictions will be displayed.

If an engine failure is detected after the all engine takeoff flight phase is complete, there will be no automatic engine out VNAV function as well as no modification of the Climb page.

Note: Prior to the all engine flight phase completion, with an engine failure detected, the Climb page is modified as depicted in the following illustration.



1 All Engines

Line select key 4L terminates the engine out takeoff mode and activates the normal climb mode.

Climb Phase

During the takeoff flight phase prior to the flap acceleration height the FMC calculates and issues a speed target equal to V2 + 20 KCAS. V2 will be obtained from the MCP speed window. The V2 speed set in the MCP speed window cannot be changed after reaching 60 knots. VNAV continues to generate this speed target until reaching the all engine acceleration height indicated on the TAKEOFF REF page. The speed target then changes to the pre-planned climb speed profile subject to applicable speed limits for the current configuration.

Climb Profile Speed Targets

With VNAV armed for the climb phase, VNAV commands acceleration to:

- last MCP speed (V2) + 20 kts until acceleration height
- the flap placard speed minus 5 kts
- 230 kts or less when leading edge flaps are not fully retracted
- 250 knots with flaps retracted
- the active target speed

- waypoint speed constraints, or
- the speed restriction associated with the origin airport, whichever is more restrictive.

Climb Profile Speed Target Exceptions

An exception to the standard climb speed profile is flown:

- if VNAV initiates a level off prior to reaching the acceleration height for either of the following reasons, then the speed target changes at the level off initiation as though the airplane had reached the planned acceleration height.

  •profile altitude constraint or MCP altitude capture.

  •cruise altitude capture.
- if an engine failure is detected, target speed will be last MCP speed (V2) + 20 kts if the airplane is at that speed or greater, or the existing speed if the airplane is between V2 and V2 + 20 kts
- if an engine failure is detected and the engine out acceleration height is reached or VNAV guidance initiates a level-off prior to engine out acceleration height the VNAV target speed will change to VREF + 70 KCAS (flaps up maneuver speed)

At the climb thrust reduction point, the FMC commands a reduction to the selected climb thrust. Passing 10,000 feet, VNAV commands an acceleration to the economy climb speed, which is maintained until entering the cruise phase. Waypoint speed constraints take priority if slower than target speed.

During the climb, VNAV complies with the LEGS page waypoint altitude and speed constraints. A temporary level–off for a crossing altitude restriction is accomplished at the current commanded speed.

When the climb speed profile causes an anticipated violation of a waypoint altitude constraint, the FMC displays the CDU scratchpad message UNABLE NEXT ALTITUDE. A different speed profile that provides a steeper climb angle must be manually selected.

When the speed profile causes an anticipated violation of a waypoint speed constraint, the FMC displays the CDU scratchpad message UNABLE YYY KNOTS AT XXXXX, where speed is YYY and waypoint is XXXXX.

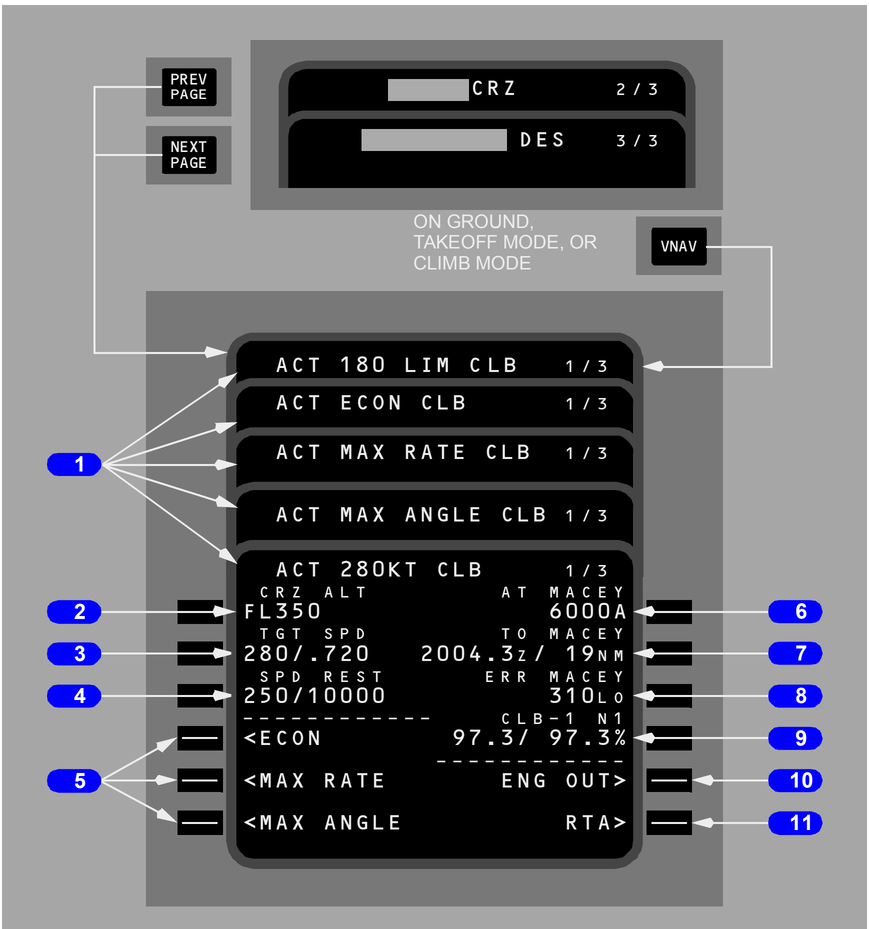
If a CLB 1 or CLB 2 derate is selected, the derate is maintained for the initial part of the climb. Thrust eventually increases to maximum climb thrust by 15,000 feet.

Climb Page

The climb page is used to evaluate, monitor, and modify the climb path. The data on the climb page comes from preflight entries made on the route and performance pages.

The climb page is automatically selected by pushing the VNAV function key on the ground and during takeoff and climb. The climb page is the first of the three pages selected with the VNAV function key. Access from other performance pages is via the NEXT/PREV PAGE key. The TAKEOFF REF page automatically transitions to the climb page after takeoff.

The FMC climb mode can be economy or fixed speed. In either mode, similar data is displayed on the page.



1 Page Title

The page title displays the type of climb. Normally, the title displays ECON for the economy climb mode. Fixed speed climbs modify the title.

XXX LIM CLB indicates the limit speed, XXX, is based on leading or trailing edge flaps:

- target speed is 5 knots below trailing edge flap placard speed
- speed is limited to 230 kts if leading edge devices are not completely retracted

ECON indicates the speed is based on a cost index.

MAX RATE indicates the speed is based on the maximum altitude over the shortest period of time.

MAX ANGLE indicates the speed is based on the maximum altitude over the shortest horizontal distance.

Fixed climb speeds display XXXKT for a fixed CAS climb speed or M.XXX for a fixed Mach climb speed profile. Reasons for fixed speeds are:

- takeoff/climb acceleration segment constraints
- waypoint speed constraints
- an altitude constraint associated with a speed constraint
- a speed restriction
- a crew entered speed.

Displays ACT when the climb phase is active.

2 Cruise Altitude (CRZ ALT)

The cruise altitude from the PERF INIT page is displayed. The altitude can be changed by two methods:

- a new altitude can be manually entered from the CDU at any time. Changing the altitude in this manner creates a modification.
- setting the MCP altitude above the current FMC CRZ altitude, provided no intermediate altitude constraints exist between the current airplane altitude and the MCP target altitude. Selecting the new altitude on the MCP and pushing the altitude intervention button places the new altitude in the CRZ ALT data line. Entering a new cruise altitude in this manner does not create a modification.

3 Target Speed (TGT SPD)

Displays computed values or manually entered values for the selected mode.

Displays XXX/MCP when speed intervention is active and plan is active.

Airspeed and/or Mach may be entered using the keyboard. Title will display manually entered value.

The active controlling speed is highlighted in reverse video.

4 Speed Restriction (SPD REST)

The speed restriction line displays the speed restriction/altitude from one of the following sources:

- the navigation database value for the origin airport (dashes displayed when no speed restriction exists for the listed airport)
- waypoint related restriction from the RTE LEGS page if restriction limits climb speed
- a default speed of 250 knots and 10,000 feet for airports not listed in the navigation database (example 250/10000)
- displays XXX/FLAPS if the active speed restriction is lower than the minimum speed for the selected flap setting
- displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

Dashes displayed if no active speed restriction exists.

Manual crew entries or deletions may be made. HOLD or FLAPS speed may not be deleted or modified.

Note: If the FMC default speed restriction is overwritten, it will be deleted and not return after the overwrite condition passes (e.g. the default of 250/10000 is overwritten to 230/3000, after 3000 feet is passed there will be no speed restriction and VNAV will accelerate to the unrestricted climb speed).

The active controlling speed is highlighted in reverse video.

5 Climb Page Prompts

Push – selects various CLB pages.

Following line selection, the prompt for that page blanks.

6 AT XXXXX

The waypoint constraint line displays the waypoint and constraining altitude of the current VNAV altitude target. Constraints are entered on the RTE LEGS page or by departure procedure selection. The constraints can be deleted on this page or the RTE LEGS page. The waypoint may be a HOLD AT point.

Display is blank if no restriction exists.

7 TO XXXXXX

Displays ETA and distance to go to waypoint on AT XXXXXX line.

If no waypoint constraint exists, values are for CRZ ALT.

8 **Error (ERR XXXXX)**

Displays predicted altitude undershoot for the waypoint on AT XXXXXX line.

During VNAV operation, the FMC commands a level off if an overshoot is predicted.

Display is blank, including the label, if no error exists.

9 **Climb N1 (CLB N1, CLB – X N1)**

Displays the computed climb N1 value.

10 **Engine Out (ENG OUT)**

Push – displays RT ENG OUT and LT ENG OUT prompts. See ENG OUT CLB page description.

Selection will also load the engine–out SID if the following conditions are true:

- an engine–out SID exists for the ACTIVE departure runway
- an engine–out SID is not already selected for the active route
- the EO SID disarm waypoint has not been reached if designated in the active route, regardless of flap position
- if no disarm waypoint exists for the SID, and flaps are not up and have not been up since takeoff was started
- flight phase is takeoff or climb
- the airspeed is greater than 80 kts (airborne).

When the above conditions are met and there is a loss of thrust or split between the thrust levers, the FMC will automatically load the engine-out SID upon detection of the engine-out condition.

An EO SID disarm waypoint may be coded into the EO SID. When a flight plan is executed, it will be searched to see if the disarm waypoint exists in the active plan. The EO SID will remain armed until that waypoint is sequenced regardless of flap position. If no disarm waypoint exists in the flight plan the EO SID auto-loading will revert to a flap based loading.

11 **Required Time of Arrival (RTA)**

Push – displays the RTA PROGRESS page.

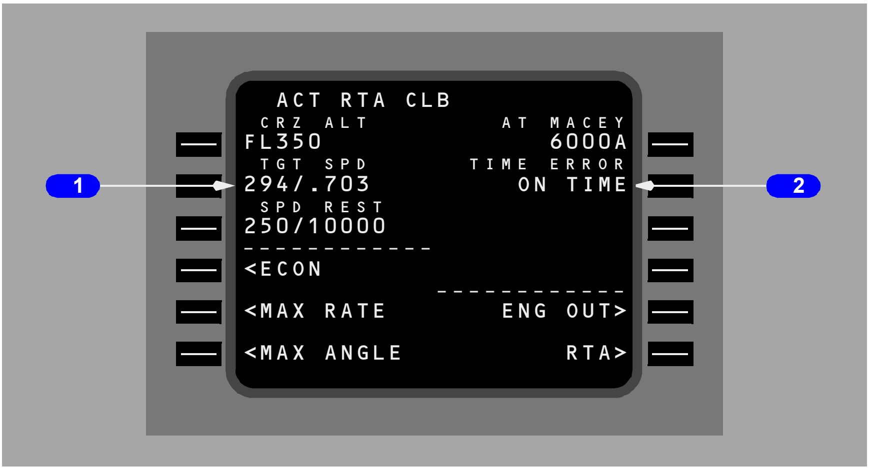
ERASE prompt replaces RTA during a page modification.

RTA Climb Page

The RTA climb page is displayed when a required time of arrival is active.

During climb, the RTA climb page is automatically selected by pushing the VNAV function key when RTA is active.

Displays on this page are the same as other climb pages except as noted.



1 **Target Speed (TGT SPD)**

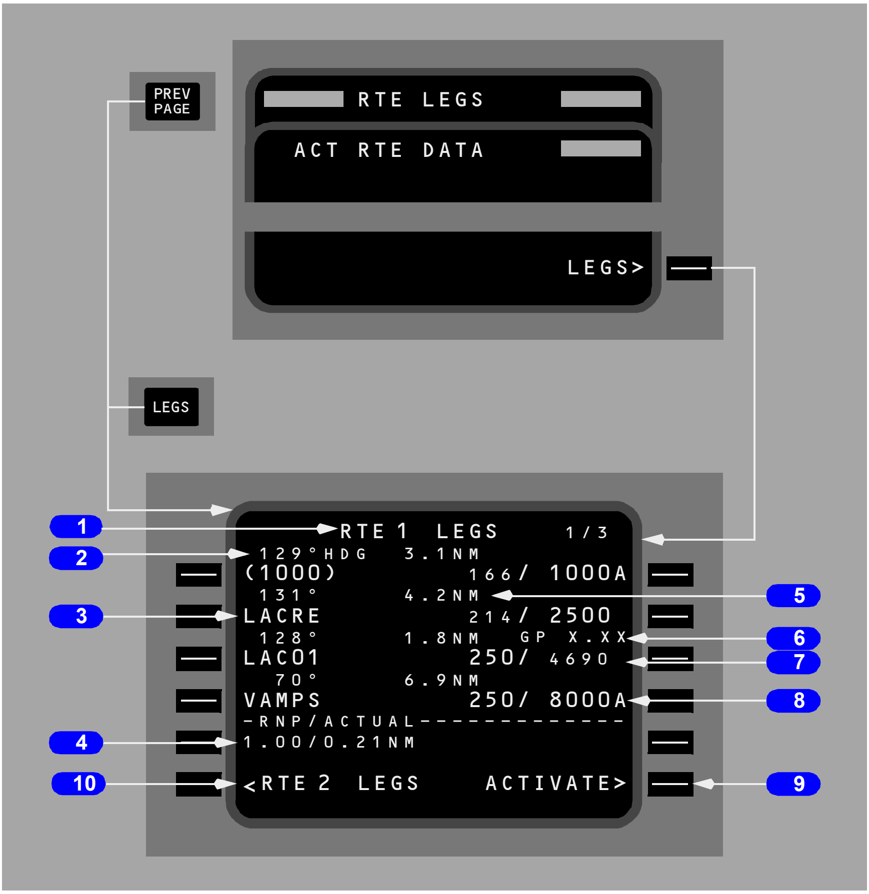
Displays computed speed required to meet entered RTA.

When RTA is exited by waypoint sequence or deletion, this speed changes to FMC target speed.

2 **TIME ERROR**

Displays computed time error at RTA waypoint. Same as RTA PROGRESS page.

RTE LEGS Page



1 Page Title

An active route legs page title is displayed with ACT as part of the title. It can be either RTE 1 LEGS or RTE 2 LEGS that is ACT. When an inactive RTE 1 LEGS or RTE 2 LEGS is selected for display, the title (RTE 1 LEGS or RTE 2 LEGS) will be in cyan color.

2 Leg Direction

The leg segment direction is displayed as the title of the waypoint line. Courses are displayed in magnetic (xxx°) or true (xxx° T). Directions to maintain an arc display the arc distance, the word ARC followed by the direction, and left or right (24 ARC L). The computed great circle route leg directions may be different than chart values. Heading leg segments to conditional waypoints are displayed as (xxx° HDG) and track leg segments are displayed as (xxx° TRK). Directions may be displayed as special procedural instructions, such as HOLD AT or PROC TURN.

Display is blank for an undefined course.

3 Waypoint Identifier

The current active leg is always displayed at the top of the first active RTE (X) LEGS page.

All route waypoints are displayed. Waypoints on an airway are included on the route legs page. Waypoints appear in flight sequence.

Waypoints can be entered and moved. This includes:

- adding new waypoints
- removing existing waypoints
- resequencing existing waypoints
- linking route discontinuities.

Displays the waypoint by name or condition.

Box prompts are displayed for route discontinuities.

Dashes are displayed for the next line beyond the end of the route.

4 Required Navigational Position/Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigation accuracy.

Manual entry is allowed.

5 Distance to Waypoint

Displays the distance from the airplane or the waypoint to the next waypoint.

6 Vertical Angle Leg

If a leg has a vertical angle from the NDB or has an FPA manually entered on the DEP/ARR page then GP X.XX° (where X.XX is the angle) is displayed.

If "TEMP COMP" is enabled and a leg has a vertical angle from the NDB or has an FPA manually entered on the DEP/ARR page and no "TEMP COMP" then 'GP X.XX' (where X.XX is the angle) is displayed. If an angle is compensated for temperature "TEMP COMP" then a "Δ" will preceed the angle "ΔGP X.XX°".

7 Calculated Waypoint Speed/Altitude

Displays the calculated speed or altitude at the waypoint in small font.

8 Specified Waypoint Speed/Altitude

Displays any waypoint speed or altitude constraint in large font.

Manual entry is allowed.

9 ACTIVATE, RTE DATA

The activate prompt is displayed on the legs page when the route is not active.

Push –

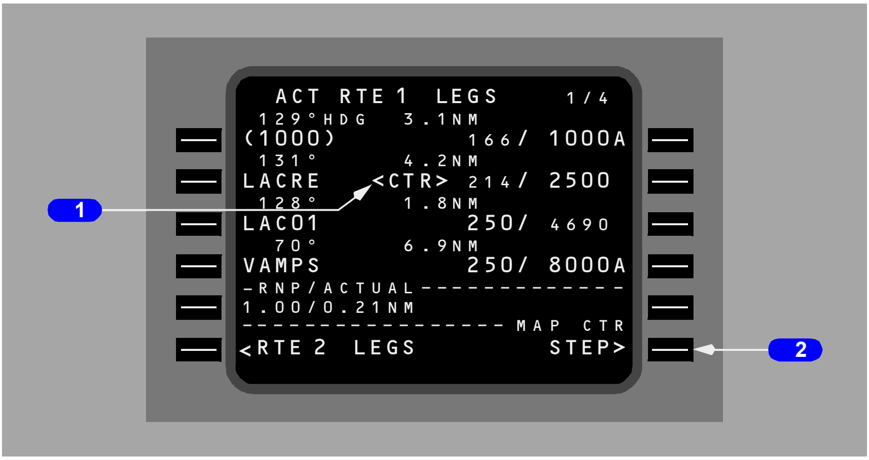
- ACTIVATE arms the execute function. Pushing the EXEC key activates the route and changes the ACTIVATE prompt to RTE DATA
- RTE DATA displays the route data page. The RTE DATA prompt is used to review or modify additional information about the route.

10 RTE (1 or 2) LEGS

Push – Displays RTE LEGS page that is at LSK 6L, either RTE 1 LEGS or RTE 2 LEGS.

Map Center Step Display

The map center step prompt replaces ACTIVATE or RTE DATA when the EFIS control panel mode selector is placed in the PLAN position. Pushing the prompt key advances the waypoint that is displayed in the center of the navigation display. The label <CTR> is displayed to the right of the corresponding waypoint on the RTE LEGS page.



1 Map Center Label (<CTR>)

Identifies the waypoint around which the map display is centered.

Whenever the EFIS Mode selector is positioned to PLAN, the label is automatically displayed for the first geographically fixed waypoint on the displayed page.

2 STEP

Displayed on a CDU when PLAN is selected on the associated EFIS control panel. Replaces the RTE DATA or ACTIVATE prompt.

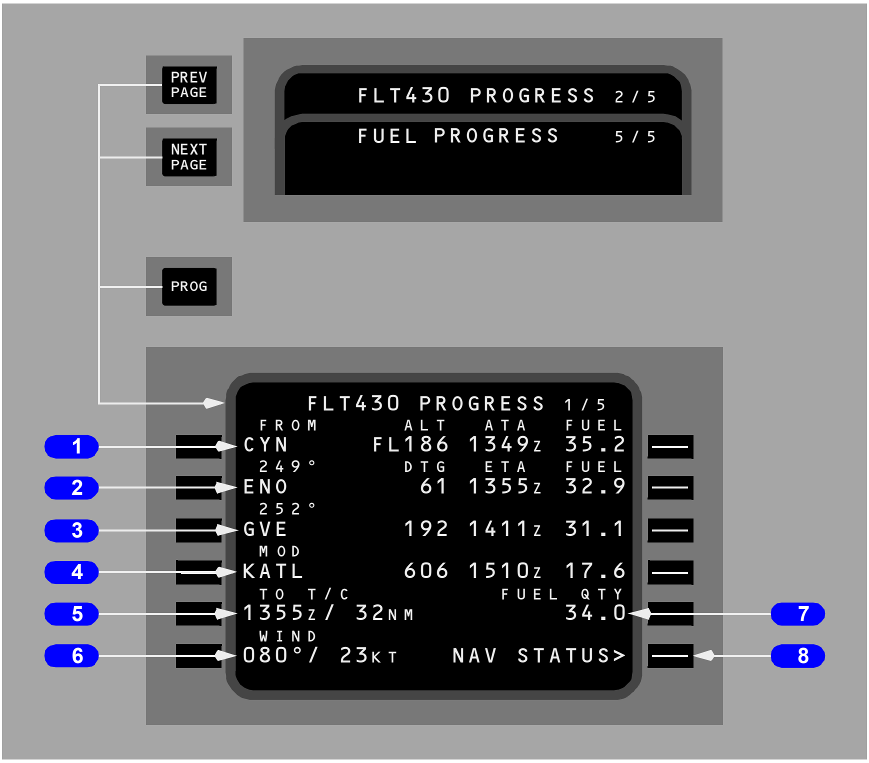
Push – moves the map center label to the next geographically fixed waypoint in the route.

Progress Page 1/5

The progress page provides general flight progress information along the route of flight such as:

- waypoints (last, active and next)
- waypoint ETA
- waypoint ATA
- distance to go information
- destination information
- altitude change points
- current wind
- fuel quantity

The page title displays the company flight number from the RTE page.



1 FROM

Displays the identifier of the last (FROM) waypoint, the altitude (ALT), the actual time of arrival (ATA), and the fuel at that waypoint.

2 Active Waypoint

Displays the identifier of the active waypoint, the flight plan course to the active waypoint, and distance–to–go (DTG) from present position to the active waypoint. Also displays the estimated time of arrival (ETA) and predicted fuel remaining at the active waypoint. The active waypoint is highlighted by reverse video.

3 Next Waypoint

Displays the identifier of the next waypoint which follows the active waypoint, the flight plan course for that leg, and flight plan distance–to–go (DTG) from present position to the next waypoint. Also displays the estimated time of arrival (ETA) and predicted fuel remaining at the next waypoint.

4 Destination

Displays the identifier of the destination airport (DEST) and flight plan distance–to–go (DTG) from present position to the destination. Also displays estimated time of arrival (ETA) and predicted fuel remaining at the destination.

When a route modification is in progress, the destination line label displays MOD. Performance predictions include the modification.

Highlighting is used to identify the MOD or INACT destination field.

5 Altitude Change Point (TO XXXXX)

Displays ETA and distance to go to the following altitude change points as appropriate to phase of flight:

- TO T/C: to top of climb for the active climb
- TO STEP POINT: to the step point if a STEP TO entry is made on CRZ page
- TO T/D: to top of descent, if no STEP TO entry is made on CRZ page
- TO E/D: to the end of descent waypoint for an active path descent; blank if a path descent is not available.

6 WIND

Displays current true wind direction and speed.

7 Fuel Quantity (FUEL QTY)

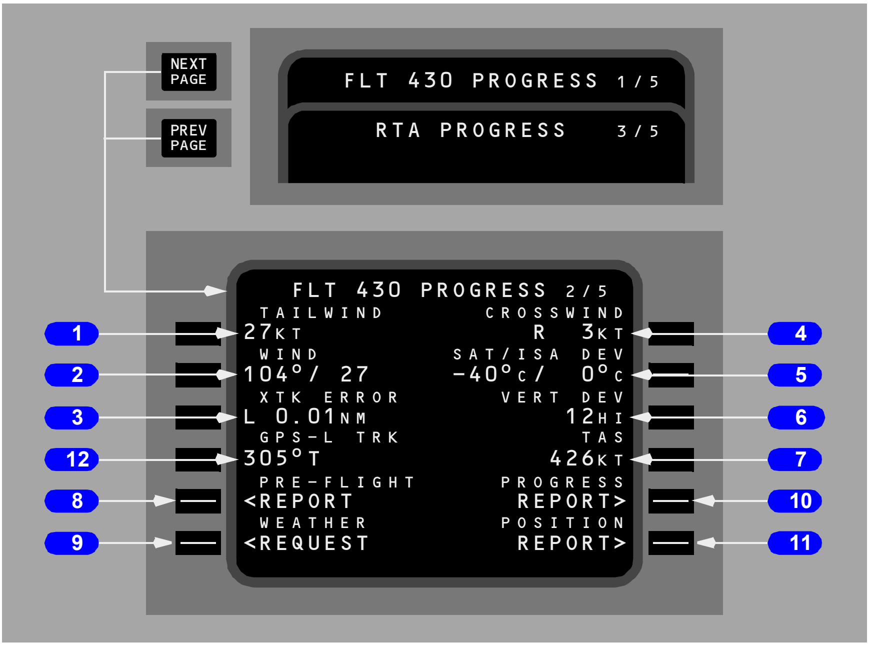
Displays the present total fuel quantity remaining as obtained from the airplane fuel quantity indication system.

8 NAV STATUS

Push – displays the navigation status page.

Progress Page 2/5

The progress page 2/5displays wind, track, path, temperature, and speed data.



1 HEADWIND or TAILWIND

Displays the present headwind or tailwind component.

2 WIND

Displays the present true wind direction/speed.

3 Crosstrack Error (XTK ERROR)

Displays present cross–track error from the desired LNAV course.

Blank if error is greater than 99.9 nm.

4 CROSSWIND

Displays present crosswind component (left or right).

5 Static Air Temperature/ISA Deviation (SAT/ISA DEV)

Displays present SAT and the equivalent ISA deviation.

6 Vertical Descent Path Deviation (VERT DEV)

Displays present computed deviation (HI or LO) from the FMC vertical path.

Blank if descent not active or path not available.

7 TAS

Displays present TAS.

8 PRE–FLIGHT REPORT

Push – transmits downlink report of preflight data.

9 WEATHER REQUEST

Push – transmits a data link request for a weather uplink.

10 PROGRESS REPORT

Push – transmits a downlink report of progress data.

11 POSITION REPORT

Push – transmits a downlink report of position data.

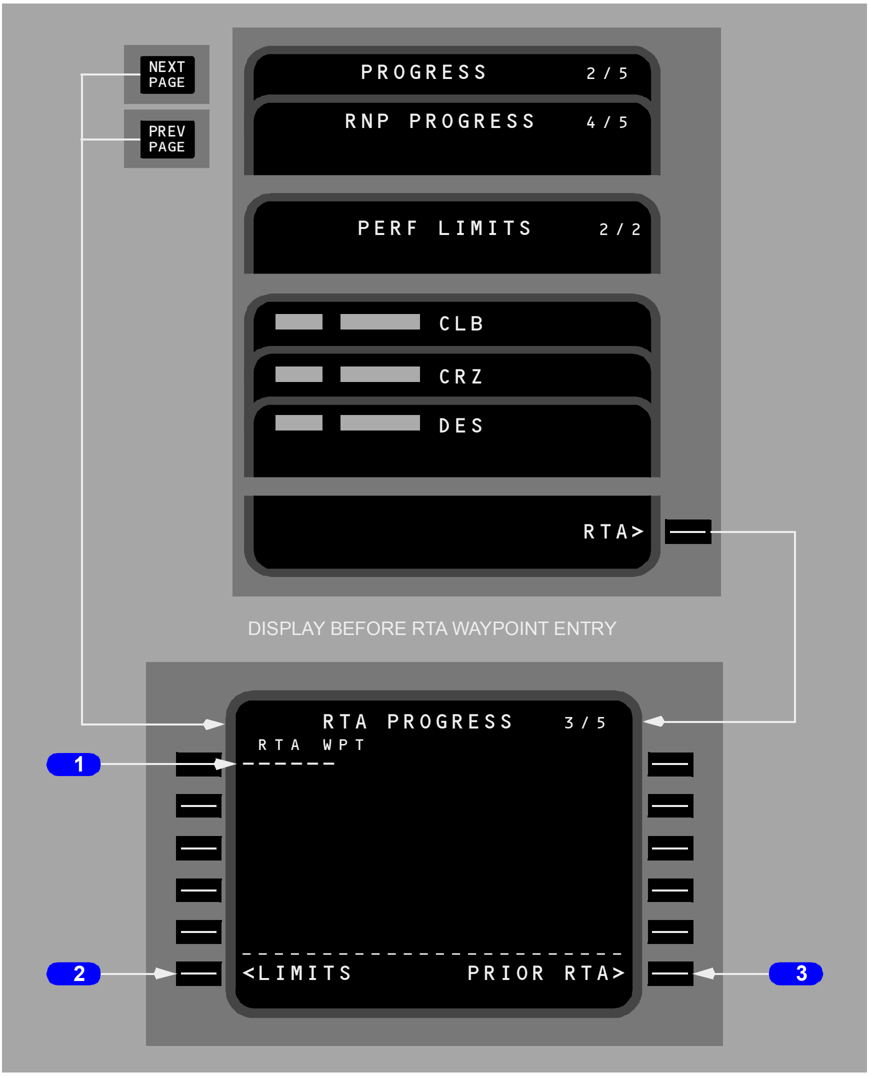
12 GPS–L TRK

Displays GPS track.

RTA Progress Page 3/5

RTA Progress page is used to initiate the required time of arrival (RTA) mode.

The RTA page provides advisory data on flight progress in the RTA mode and advises of control times such as recommended takeoff time to meet RTA.



1 Required Time of Arrival Waypoint (RTA WPT)

Displays dashes when entry allowed.

2 LIMITS

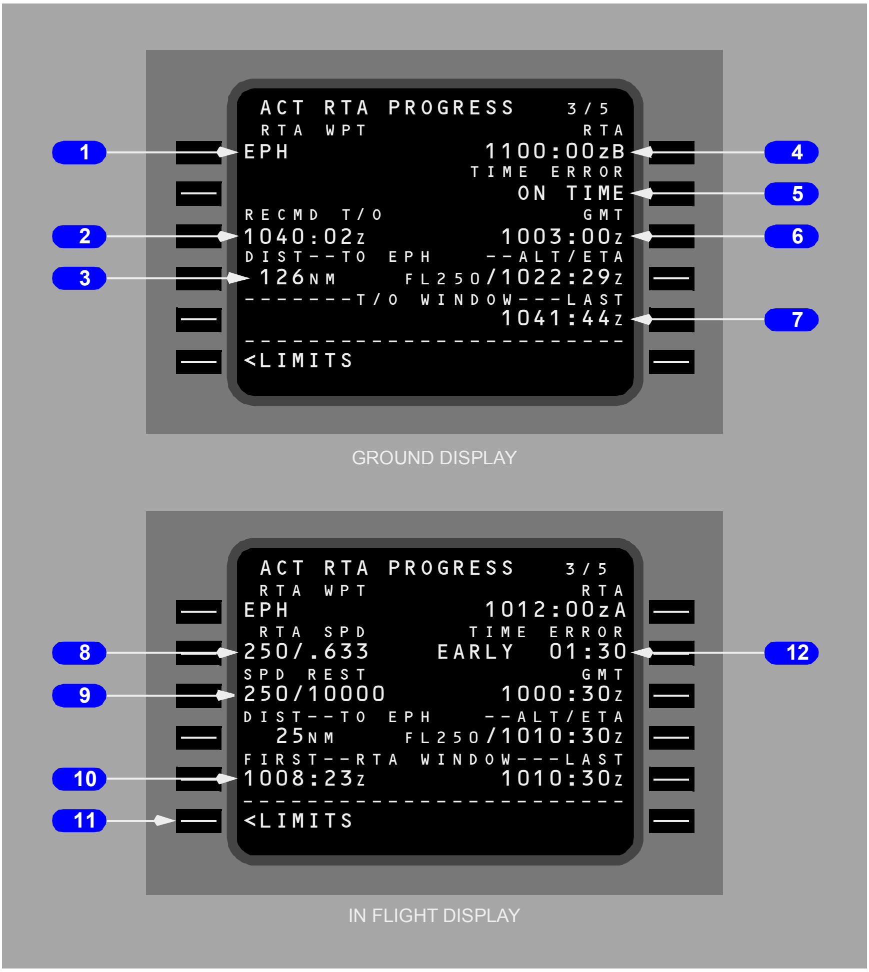
Push – displays the PERF LIMITS page.

3 Prior RTA Waypoint (PRIOR RTA)

Prompt displayed when the RTA waypoint field contains dashes and a previous RTA waypoint is still in the flight plan; otherwise blank.

Push – displays last active RTA waypoint data.

RTA Progress on Ground and in Flight



1 Required Time of Arrival Waypoint (RTA WPT)

Waypoint entry must be in flight plan or the CDU message NOT IN FLIGHT PLAN will be displayed.

Entering a valid waypoint will generate a MOD RTA PROGRESS page and illuminate the EXEC light.

Deletion of the RTA waypoint will create a MOD RTA PROGRESS page with all data blanked and EXEC light illuminated. Execution will exit the RTA mode.

Deletion of the RTA waypoint does not remove the waypoint from the flight plan.

Automatically clears the RTA waypoint and exits the RTA waypoint after sequencing the RTA waypoint out of the flight plan.

2 Recommended Takeoff Time (RECMD T/O)

Displays the recommended takeoff time (brake release time) to meet the planned RTA.

Time is based on entered Cost Index as well as the earliest and latest times to achieve RTA.

3 Distance To, Altitude, and ETA at the RTA Waypoint (DIST – – TO XXX – – ALT/ETA)

Displays the distance to the RTA waypoint.

Displays the predicted altitude at the RTA waypoint.

Displays ETA to the RTA waypoint based on:

- immediate takeoff
- MIN/MAX speeds on PERF LIMITS page
- entered forecast winds.

4 Required Time of Arrival (RTA)

After RTA waypoint entry, initially displays current ETA based on the active flight plan and performance parameters at time of waypoint entry.

Desired RTA may be entered by overwriting displayed data.

Entry must be in one of the following forms:

- XXXXXX (hr/min/sec)
- XXXX (hr/min)
- XXXX.X (hr/min/tenths of min).

Entry of “A” after RTA specifies arrival time of at or after.

Entry of “B” after RTA specifies arrival time of at or before.

5 TIME ERROR

Displays the most recent time error in minutes and seconds up to a maximum of 59:59 minutes.

Displays ON TIME if GMT is within current T/O WINDOW.

Displays EARLY or LATE as appropriate if GMT is not within current T/O WINDOW.

6 GMT

Displays the actual GMT.

7 Takeoff Window (– – – – – – – – T/O WINDOW – – – LAST) or (FIRST – – T/O WINDOW – – – – – – – –)

Displays latest takeoff time to meet the planned RTA.

If the entered RTA time is “At or After” time, only the FIRST field shall be displayed.

If the entered RTA time is “At or Before” time, only the LAST field shall be displayed.

Time is based on minimum and maximum speeds on the PERF LIMITS page.

8 Required Time of Arrival Speed (RTA SPD)

Displays the target speed required to meet the planned RTA.

Same as speed displayed on RTA CLB, CRZ, or DES page.

Limited by MIN/MAX speeds on the PERF LIMITS page and the SPD REST line.

During cruise, displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

9 Speed Restriction (SPD REST)

Displays the current speed restriction affecting RTA progress.

When not in cruise, displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

10 Arrival Time Window (FIRST – – RTA WINDOW – – – LAST)

Displays earliest and latest achievable arrival times at the RTA waypoint.

Times based on MIN/MAX speeds on PERF LIMITS page, existing winds, and entered forecast winds.

11 LIMITS

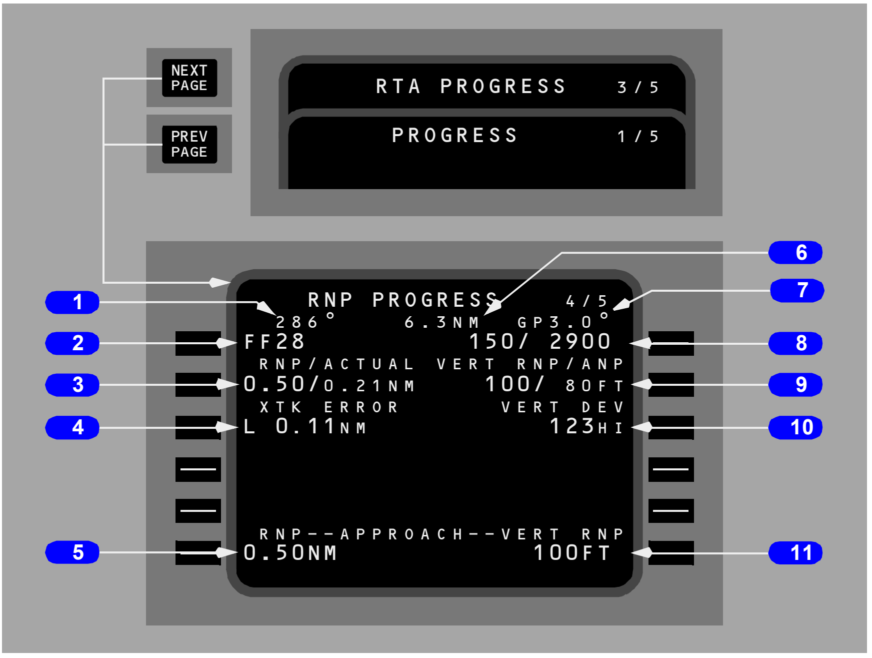
Push – displays PERF LIMITS page.

12 TIME ERROR

In flight, displays difference between the ETA and the RTA plus the TIME ERROR TOLERANCE on the PERF LIMITS page.

RNP Progress Page 4/5

Progress page 4/5 displays essential Required Navigation Performance (RNP) information. The items displayed include waypoint identifier, RNP and ANP values, course, distance, glide path, cross track error, speeds, altitudes and vertical deviation.



1 **Leg Direction**

The leg segment direction is displayed as the title of the waypoint line. Courses are displayed in magnetic (xxx°) or true (xxx° T). Directions to maintain an arc display the arc distance, the word ARC followed by the direction, and left or right (24 ARC L). The computed great circle route leg directions may be different than chart values. Heading leg segments to conditional waypoints are displayed as (xxx° HDG) and track leg segments are displayed as (xxx° TRK). Directions may be displayed as special procedural instructions, such as HOLD AT or PROC TURN.

Display is blank for an undefined course.

2 **Waypoint Identifier**

Displays the next waypoint.

Same as displayed on the RTE LEGS page.

3 **RNP / ACTUAL**

Displays the current FMC RNP / ANP values. The RNP may be overwritten (manual entries are displayed in large font) and affects the approach RNP 6L value. The RNP value displayed is selected from the performance defaults database if not specified in the navigation database.

Same as displayed on the POS SHIFT page.

4 **Crosstrack Error (XTK ERROR)**

Displays present cross–track error from the desired LNAV course.

L or R indicates left or right of course.

Blank if error is greater than 99.9 nm.

5 **Lateral RNP (Approach)**

Displays the lowest RNP (initial, intermediate or final segment) for the selected approach

Displays in large font for 3L manually entered RNP values.

Displays in small font for values provided by the navigation database.

6 **Distance To Go**

Displays the distance remaining to the next waypoint.

7 **Glide Path**

Displays the FMC computed glide path for the approach.

8 **Waypoint Speed/Altitude**

Displays waypoint speed or altitude constraints in large font.

Displays FMC predicted values in small font when no restrictions have been specified.

9 **Vertical Navigation Performance**

Displays both the vertical RNP (Required Navigation Performance) and the vertical ANP (Actual Navigation Performance) for the current leg.

Valid display range for vertical ANP is 0 to 999 feet.

Manual entries are allowed and are displayed in large font.

Valid entries are 10 to 999 feet and may be suffixed with an optional “/“

Entries are cleared at flight completion.

Values from the navigation database are displayed in small font.

10 **Vertical Deviation**

Displays present vertical deviation from the FMC computed glide path.

11 **Vertical RNP (Approach)**

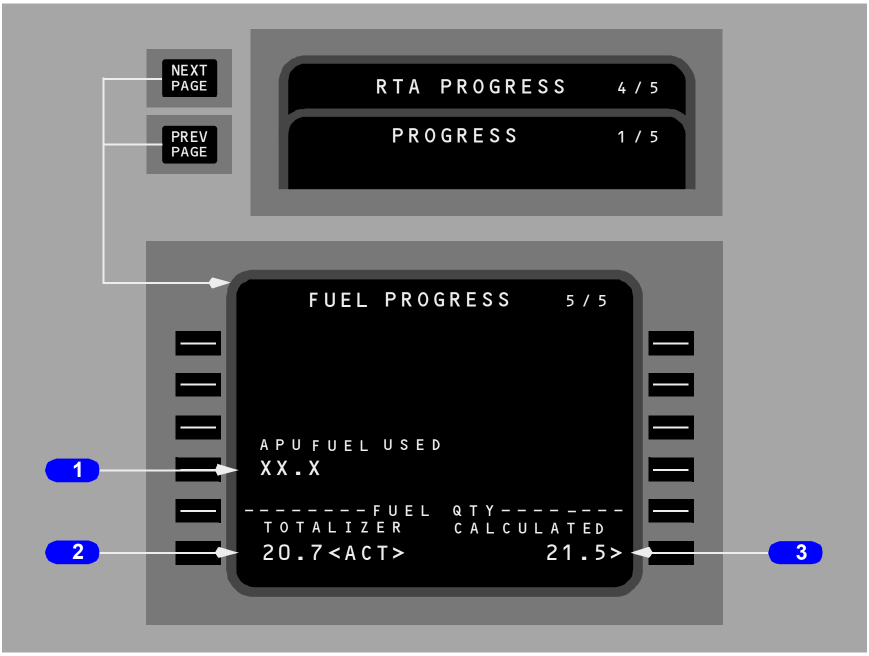
Displays the lowest applicable vertical RNP for the approach.

Manual entries (entered in 2R) are displayed in large font.

Values from the navigation database are displayed in small font.

FUEL Progress Page 5/5

FUEL PROGRESS 5/5 page supports the Extended Range Operations (ETOPS) Fuel Requirements. The individual engine fuel used data is still shown on the forward instrument panel on the engine display, only APU fuel used and fuel quantity is shown on this page. The crew can select a fuel source for use by the FMC for performance predictions. The system default on power up, and after flight complete will be TOTALIZER.



1 **APU FUEL USED**

Displays the Auxiliary Power Unit (APU) fuel used.

2 TOTALIZER

Shows fuel quantity from the Fuel Quantity Indication System (FQIS). Selection results in the FMC using the FQIS fuel quantity for predictions. The TOTALIZER is the system default at power up.

3 CALCULATED

Shows CALCULATED fuel based on the totalizer value at engine start decreased by fuel flow data or manual input of fuel quantity decreased by fuel flow data. Selection results in the FMC using the calculated fuel quantity for predictions.

N1 Limit Page

This section describes the in–flight version of the N1 LIMIT page. See the FMC Preflight section for a description of the preflight version of the N1 LIMIT page.

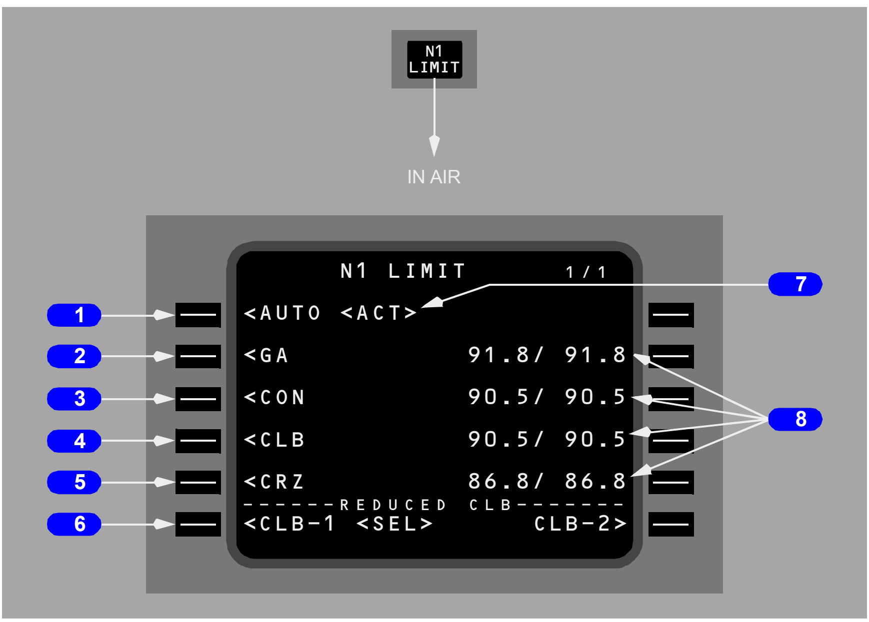
Normally, N1 limits are automatically specified. Pilot selection of other limits is allowed.

Pilot selection of a reduced climb mode does not change the automatic selection for other phases of flight.

Pilot selected mode is automatically replaced by AUTO selection when the autopilot next changes vertical mode.

The active thrust limit is used by the autopilot and is displayed on the thrust mode display.

An optional increase in available cruise thrust limits is available via a custom Loadable Defaults Database (LDDB). The default cruise N1 thrust rating is CRZ where cruise N1 limits are used as the default cruise thrust rating. The optional setting is CLB where climb N1 limits are used as the default cruise thrust rating.



1 **AUTO**

Push – selects automatic computation of N1 limits for all phases of flight.

2 **Go Around (GA)**

Push – selects the go–around thrust limit.

3 **Continuous (CON)**

Push – selects the maximum continuous thrust limit.

4 **Climb (CLB)**

Push – changes the thrust mode from AUTO to the active climb thrust, i.e. CLB, CLB–1, or CLB–2.

5 **Cruise (CRZ)**

Push – selects the cruise thrust limit.

6 **Reduced Climb (REDUCED–CLB)**

Push – selects either of two reduced climb thrust modes.

CLB–1 provides a climb limit reduced by 3% N1 (approximately 10% thrust).

CLB–2 provides a climb limit reduced by 6% N1 (approximately 20% thrust).

The reduced climb N1 value is displayed on the CLB pages.

If either mode is <SEL>, deletion allows return to full rated climb thrust.

Any reduced climb selection is automatically deleted above 15,000 feet.

Note: If a reduced thrust takeoff has been specified on the TAKEOFF REF page, then either CLB–1 or CLB–2 may be automatically specified if required to avoid a climb N1 value greater than the reduced thrust takeoff N1 value.

Note: When combining a high level of derate with a high assumed temperature, or if a climb thrust rating higher than the automatically selected climb thrust rating is selected, it is possible that the climb thrust may be higher than the takeoff thrust. In such case, thrust levers will advance forward upon reaching thrust reduction altitude.

7 **<ACT> STATUS LABEL**

Identifies the active N1 thrust limit.

8 **N1**

Displays the N1 for individual thrust limits based on present conditions and bleed air configuration.

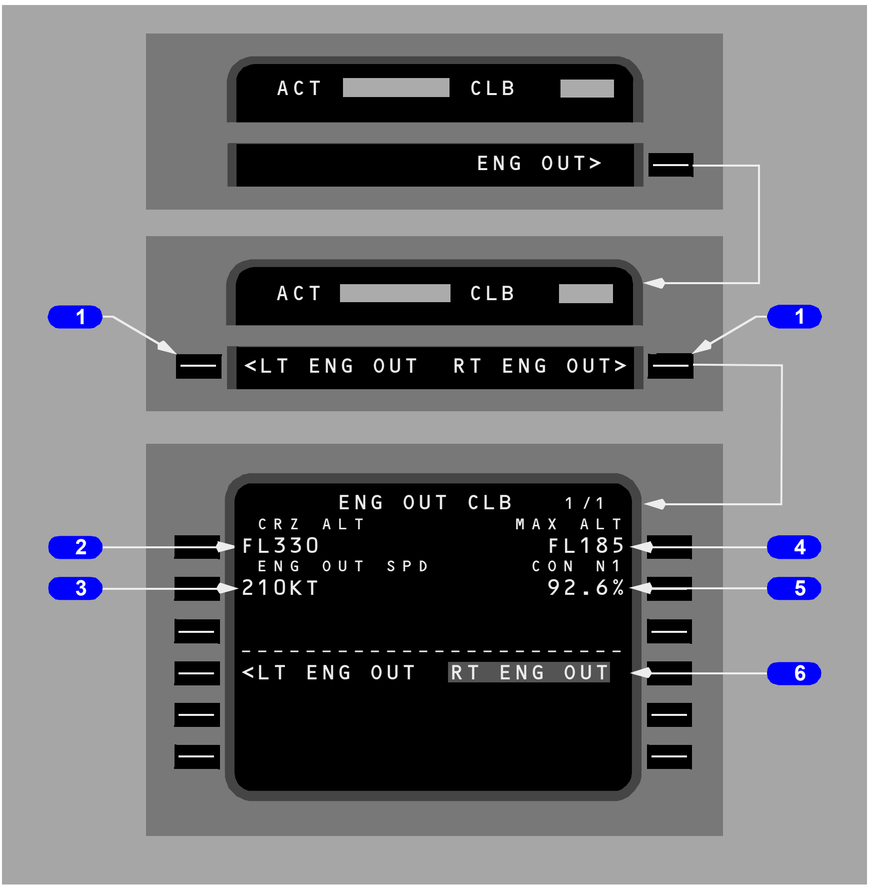
If CLB–1 or CLB–2 is selected, the N1% for CLB and the N1 cursors still display values for full rated climb.

Engine Out Climb

Engine out climb advisory data is available on the CLB page. Engine out data is also available with both engines operating. The engine out climb phase automatically transitions to the engine out cruise phase when reaching the cruise altitude.

Engine Out Climb Page

Displays advisory information for an engine inoperative condition. Once the page is selected, it cannot be executed.



1 Left/Right Engine Out (LT ENG OUT/RT ENG OUT)

Displayed after selection of ENG OUT prompt.

2 **Cruise Altitude (CRZ ALT)**

Displays the current active cruise altitude. Value is forwarded from either the PERF INIT, CRZ, CRZ CLB, or CRZ DES pages. Manual entry not allowed.

3 **Engine Out Speed (ENG OUT SPD)**

Displays the minimum drag engine out climb speed.

4 **Maximum Altitude (MAX ALT)**

Displays the maximum altitude at which company specified rate of climb can be achieved using one engine at maximum continuous thrust.

After page selection, the FMC accounts for wing and engine anti–ice, air conditioning and engine bleed of the operating engine.

5 **Continuous N1 (CON N1)**

Displays the N1 for maximum continuous thrust.

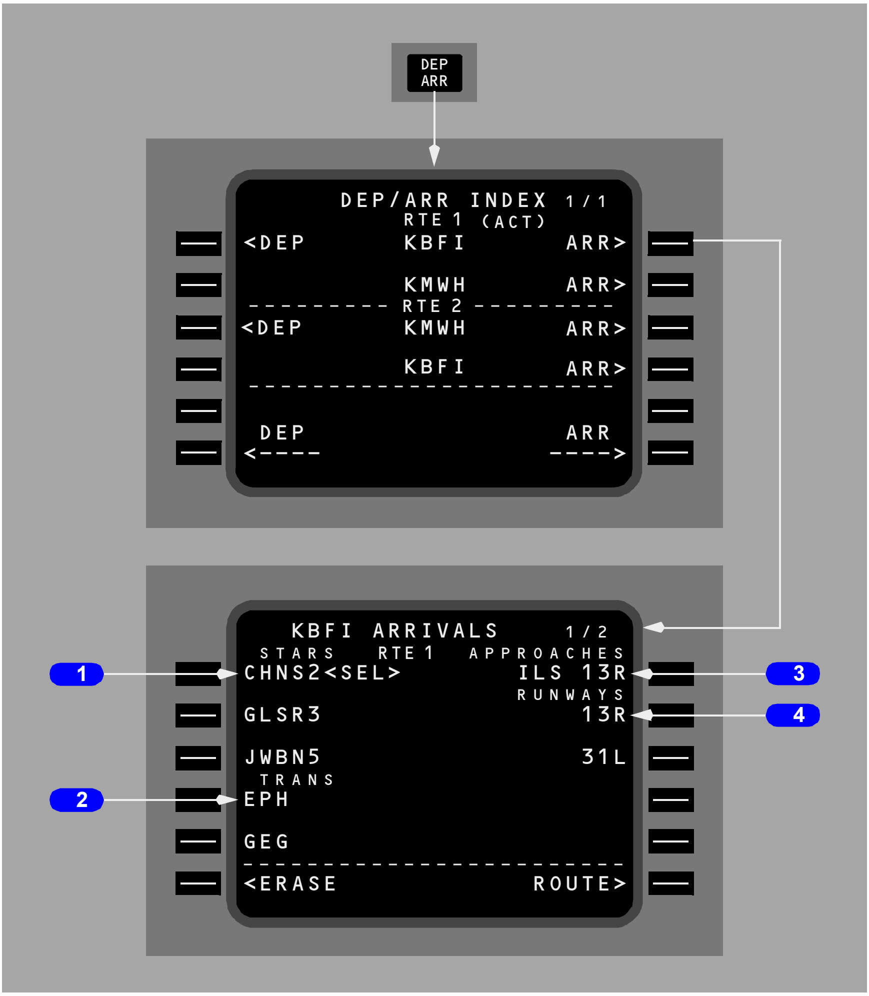
6 **LT ENG OUT/RT ENG OUT**

Selected engine is shown in reverse highlighting.

Air Turnback

Arrivals Page

During a turn–back situation, the crew requires quick access to the arrivals information for the origin airport. The departure/arrivals index and arrivals page provide access without changing the destination on the route page. See Chapter 11, Section 43 for additional information on the arrivals page.



1 Standard Terminal Arrival Routes (STARS)

Displays STARS for the origin airport.

2 **Transitions (TRANS)**

Displays transitions for the origin airport.

3 **APPROACHES**

Displays approaches for the origin airport.

4 **RUNWAYS**

Displays runways for the origin airport.

Intentionally
Blank

Introduction

The cruise phase automatically begins when the top of climb is reached.

During cruise, the primary FMC pages are:

- RTE LEGS
- PROGRESS
- CRZ.

The RTE LEGS pages are used to manage route restrictions and modify the route. The PROGRESS pages display flight progress information. RTA requirements are also specified on the PROGRESS pages. The CRZ pages display VNAV related information. Other pages include:

- POS REF page – verifies the FMC position (refer to Section 40 of this chapter)
- POS SHIFT page – permits selection of preferred position from list of references
- RTE DATA page – displays progress data for each waypoint on the RTE LEGS page. Displays wind data for cruise waypoints.
- REF NAV DATA page – displays information about waypoints, navaids, airports, or runways
- LATERAL OFFSET page – permits selection of a route offset
- FIX INFO page – displays information about waypoints, and can be used to create new waypoints and fixes
- SELECT DESIRED WAYPOINT page – permits selection of the desired waypoint from a list of duplicate named waypoints
- NAV STATUS page – displays information about available navigation aids.

The only cruise mode automatic page changes are the transition from climb to cruise at the top of climb point and from cruise to descent at the top of descent point.

LNAV Modifications

This section presents the normal techniques for modifying the route. The modifications include:

- adding and deleting waypoints
- resequencing waypoints
- linking discontinuities
- intercepting a course.

RTE LEGS Page Modifications

When modifications are made to the RTE LEGS page, several automatic prompt or identifying features assist in managing and executing the modifications, such as:

- ERASE
- INTC CRS.

Adding Waypoints

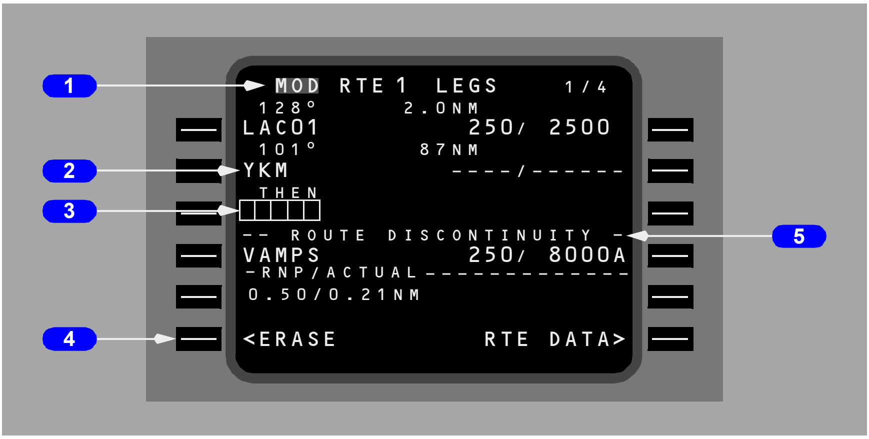
A waypoint can be added to the route whenever necessary.

The new waypoint must first be placed into the CDU scratchpad. Existing waypoints can be copied from a RTE LEGS page into the scratchpad by pushing the line select key adjacent to the desired waypoint.

The new waypoint is then inserted into the route at the desired sequence point by pushing the line select key adjacent to the desired location for the new waypoint. Using the NEXT PAGE/PREV PAGE function keys to select the desired location does not alter the CDU scratchpad. The new entry automatically links to the preceding waypoint via a direct route. Placing the new waypoint into the active waypoint line is a special case and is discussed under Intercept Course in this section.

All new waypoints, except along track waypoints, cause a route discontinuity between the new waypoint and the following waypoint.

Note: If the FMC NAV database contains a HOLD pattern at the FAF, executing a database approach with a procedure turn and then executing a HOLD at the same FAF, using any inbound course, may cause a discontinuity between the FAF and the procedure turn. If the discontinuity is removed, LNAV guidance is available to fly the approach from the published holding pattern. LNAV guidance is not available to fly the published procedure turn.



1 Page Title

When the page is modified, MOD appears in front of the title in reverse highlighting. This means the route is now altered. The MOD title also shows that the modifications are not yet executed and can be removed using the ERASE prompt.

2 Modified Waypoint

YKM waypoint is entered into the route between LAC01 and VAMPS. This modification creates a route discontinuity.

3 Discontinuity Waypoint

Box prompts indicate the requirement to link the route by entering a route waypoint into the discontinuity waypoint position.

4 ERASE

The ERASE prompt is displayed when the first modification is entered. The prompt remains on the page until the modifications are erased or executed.

Push – removes all modifications and restores all active data.

5 Discontinuity Header

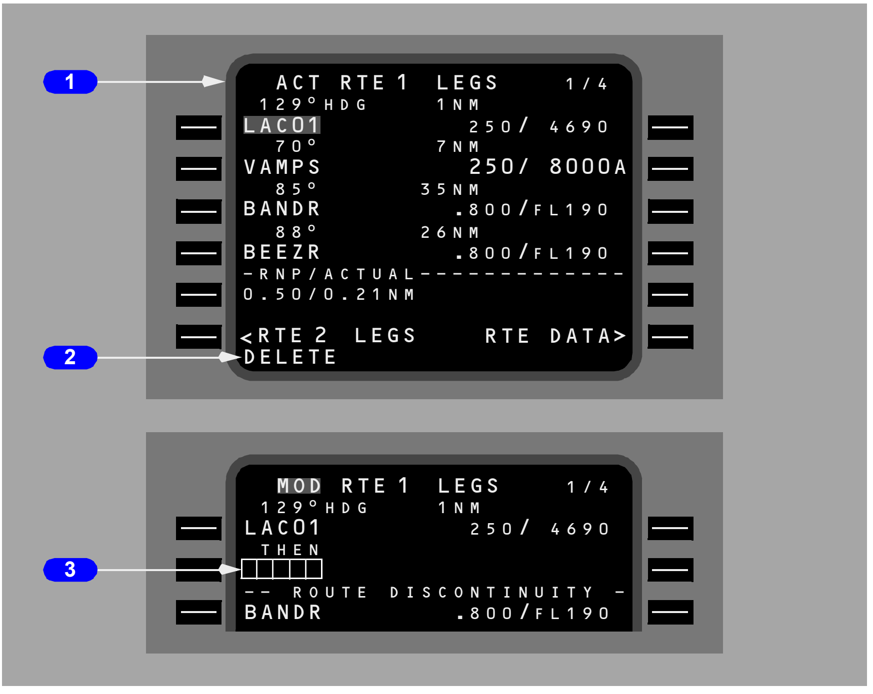
Indicates that the route is not continuous. Distance to destination on the PROGRESS page is not correct.

Deleting Waypoints

Waypoints can be removed from the RTE LEGS page. There are two normal methods to remove a waypoint:

- delete the waypoint using the DEL function key (not possible for the active waypoint and some conditional waypoints)
- resequence the route by moving a down–route waypoint up in the sequence and automatically removing all waypoints that are between.

During the deletion process, all of the route prior to the deletion point remains unchanged. Removing a waypoint using the DEL function key causes a route discontinuity to replace the deleted waypoint.



1 Active Route

The existing route shows VAMPS followed by BANDR, BEEZR, and ELN.

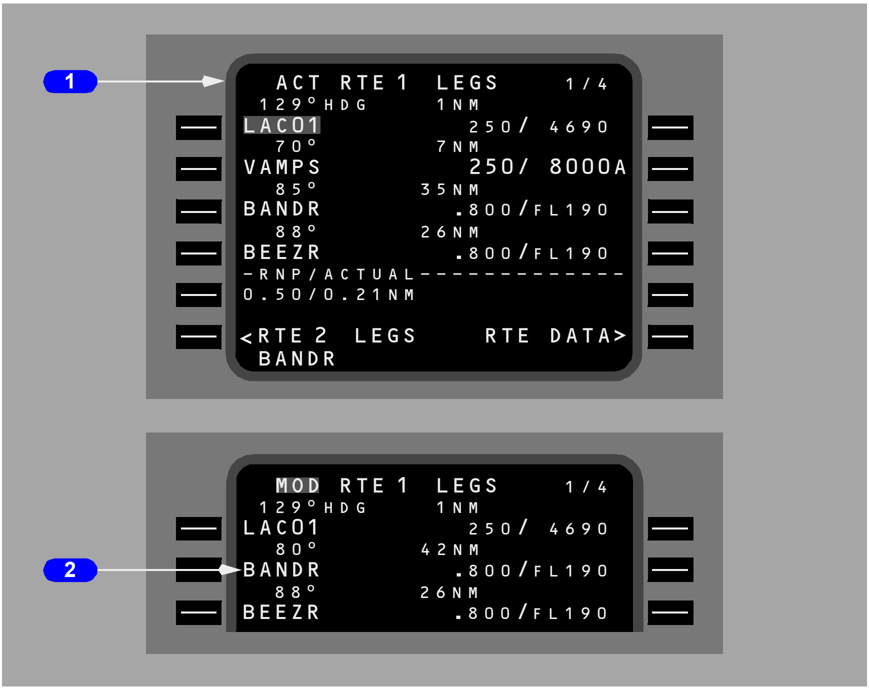
2 DELETE Entry

Push the DEL key to arm the delete function. DELETE is displayed in the scratchpad.

3 Delete VAMPS

With DELETE displayed in the scratchpad, push the line select key left of VAMPS to delete the waypoint. Box prompts replace VAMPS and a route discontinuity follows the box prompts.

Resequencing Waypoints



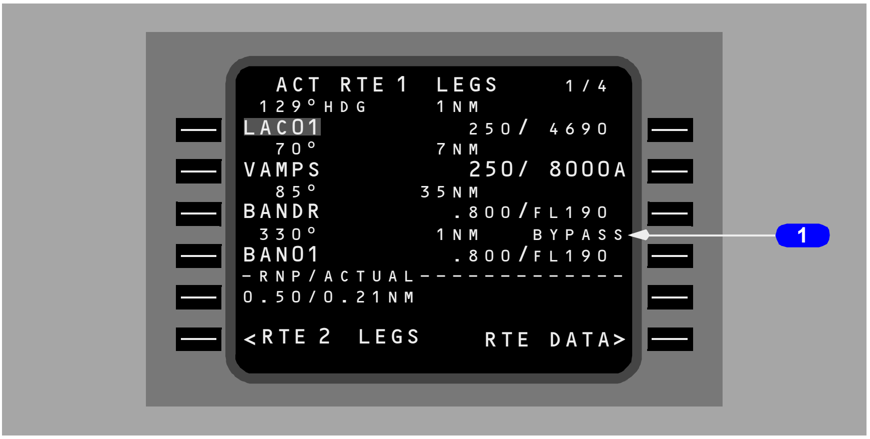
1 Active Route

The existing route shows VAMPS followed by BANDR, BEEZR, and ELN. The airplane must fly direct from LAC01 to BANDR. The BANDR waypoint is copied into the scratchpad.

2 Resequence BANDR

BANDR is transferred to the waypoint following LAC01. VAMPS is removed, and the route remains continuous.

Leg Bypass



1 Bypass Notification

A waypoint (BAN01) has been entered into the route which is very close to another route waypoint (BANDR). It is impossible for the airplane to turn and capture the leg between BANDR and BAN01, so a bypass is noted.

Turn construction is based upon FMC criteria which assumes that LNAV is engaged. Normal turn construction may not be possible under certain combinations of airspeed, short leg length, and a significant change in leg direction. If normal turn construction cannot be provided to capture the leg into a waypoint, the FMC bypasses the affected waypoint and uses alternative turn construction to intercept that leg. When the bypass is for the active waypoint, the waypoint remains active until the airplane passes abeam.

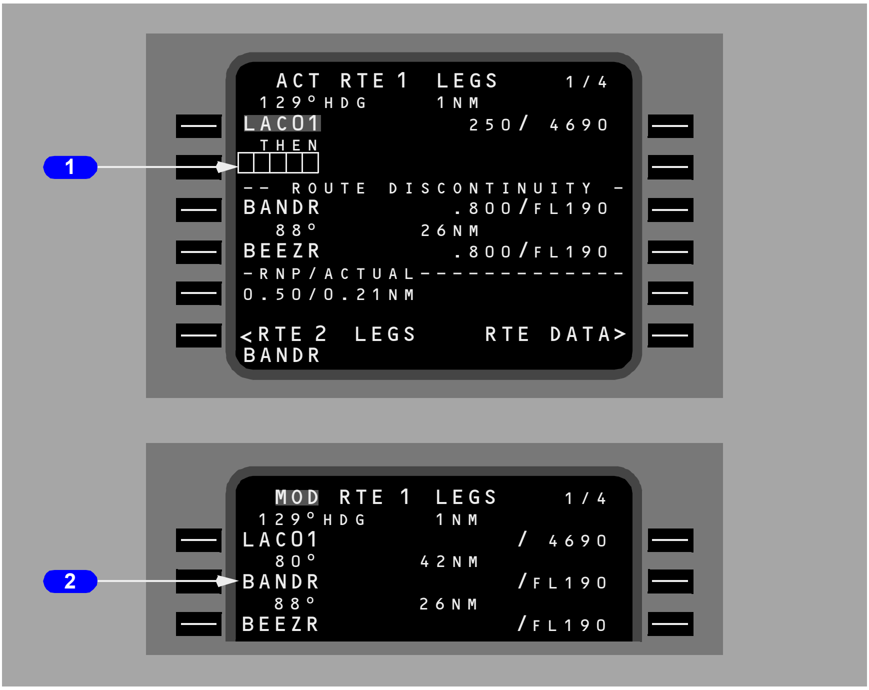
Any mandatory altitude–crossing restriction for the bypass waypoint is still observed if VNAV is engaged, based on passing abeam the waypoint.

If a triple bypass condition occurs (bypass of three consecutive legs), a route discontinuity will be inserted.

Removing Discontinuities

A discontinuity exists when the FMC is unable to determine the route leg following a waypoint. Discontinuities are removed by linking the route segment following the discontinuity to the route segment preceding the discontinuity.

The next desired waypoint from the subsequent route is copied into the CDU scratchpad and entered into the discontinuity, just as when adding a waypoint.



1 ROUTE DISCONTINUITY

The active route shows a discontinuity. The airplane must fly direct from LAC01 to BANDR. The BANDR waypoint is copied into the scratchpad in preparation to remove the discontinuity. Any waypoint from the route can be copied into the scratchpad to remove the discontinuity.

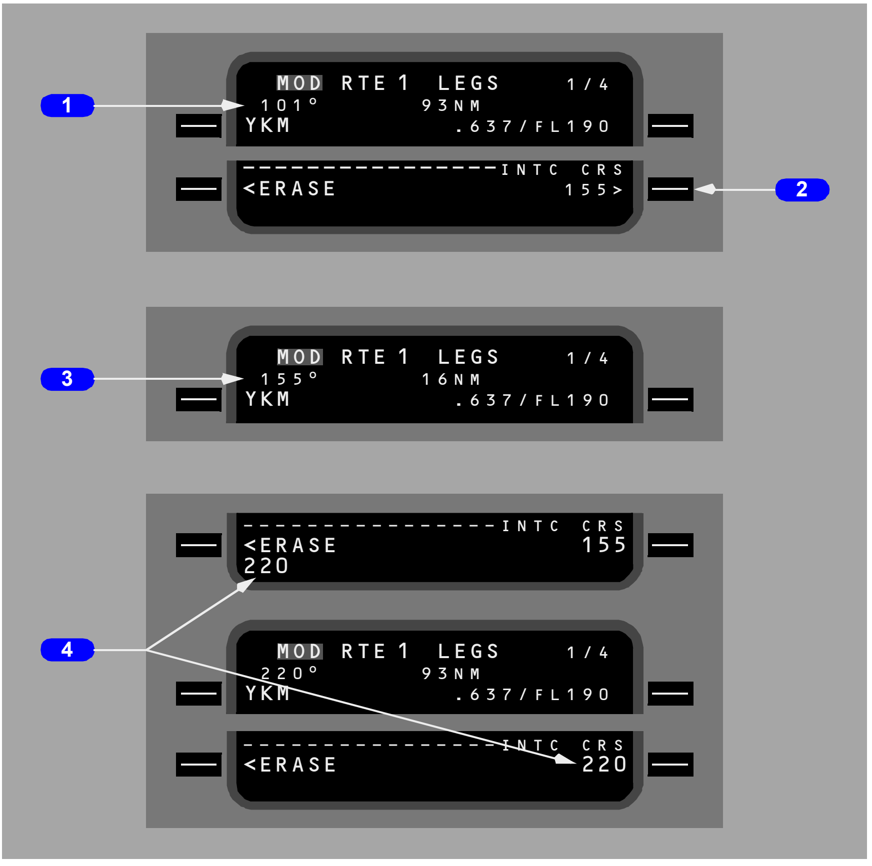
2 Continuous Route

BANDR is copied into the box prompts to remove the discontinuity.

Entering a waypoint which does not already exist on the route moves the discontinuity one waypoint farther down the route.

Direct To and Intercept Course

To fly direct to a waypoint or intercept a course to a waypoint, enter the waypoint name on RTE LEGS page 1 active waypoint line. The INTC CRS prompt displays in line 6R. The example shows the result with YKM entered into the active waypoint line.



1 Direct Course

Direct course from airplane present position to entered waypoint.

Execute to proceed direct to active waypoint.

2 Intercept Course (INTC CRS)

Push – puts displayed course (155) into active waypoint leg direction. Enables intercept course function.

Displayed whenever the active waypoint name is modified.

Displays flight plan leg direction to entered waypoint in small font. Displays dashes if entered waypoint was not in the flight plan.

Valid input is any course from 000 through 360. May be changed until executed. Entered or selected value displays in large font.

3 Leg Direction

Displays the course inbound to the active waypoint after selecting the course displayed in the INTC CRS line.

4 Intercept Course (INTC CRS) – Change

Enter the inbound intercept course to the modified waypoint in the scratchpad.

Select the INTC CRS line to change the leg direction.

The example shows 220° intercept course to YKM entered in the INTC CRS line.

Select Desired Waypoint Page

When a waypoint identifier is not unique (other database waypoints have the same name), a selection of which latitude/longitude to use must be made before that waypoint can be used in the route.

The SELECT DESIRED XXX page is automatically displayed when the FMC encounters more than one identifier for the same waypoint name after a waypoint entry.

1 Identifier

Displays the identifier for the duplicate named waypoints. Select the proper waypoint by pushing the appropriate left or right line select key. This page is automatically removed after a waypoint is selected.

2 Type

Shows type of navaid.

Available types include VOR, VORTAC, VORDME, NDB, LOC, ILS, DME, ILSDME, LOCDME, APT or WPT.

3 Frequency

Displays the frequency of the navaid.

Blank if the waypoint is not a navaid.

4 Waypoint Name

Displays the name of the waypoint.

Blank if the waypoint is not a navaid.

5 Latitude/Longitude

The latitude/longitude is displayed for each duplicate name.

Airway to Airway Intercept Feature

There are two methods in which this feature can be used.

The first method in which the airway to airway feature can be used, involves picking two airways that share a common waypoint. The common waypoint acts as the terminal waypoint for the first airway and the entry waypoint for the second airway. The first airway to be used is entered in the first available VIA field, the common waypoint in the TO field, and the second airway in the next available VIA field.

The second method in which this feature can be used to create an airway to airway intercept, involves entering two airways that intersect in the first and second available VIA fields, but do not have a common waypoint at the intersection. In this case, a temporary waypoint is created, starting with the letter "X", and used as the TO waypoint.

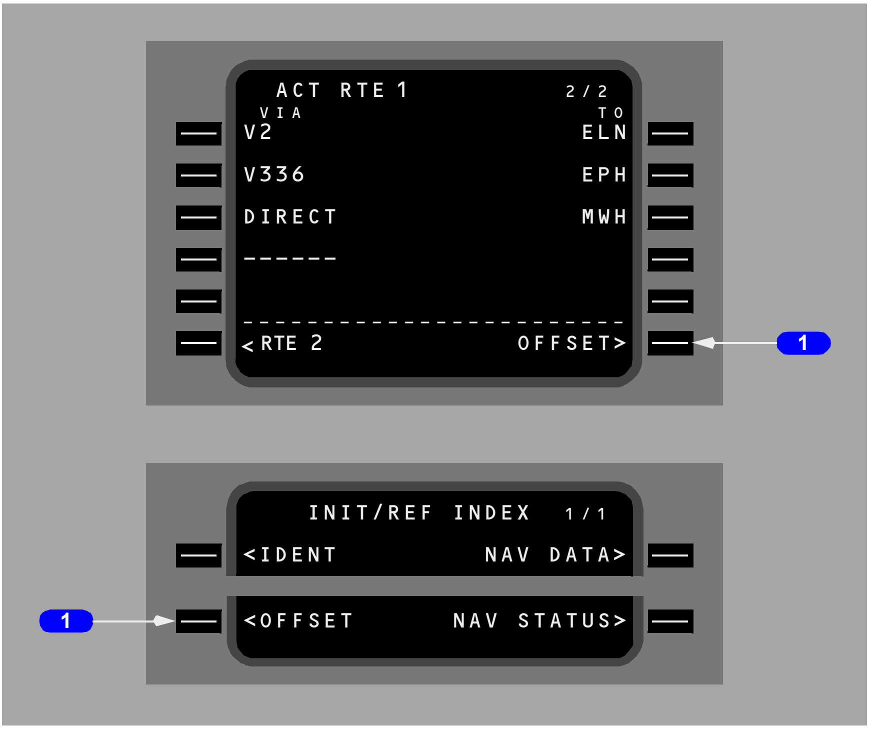
Lateral Offset

A lateral offset may be specified up to 99.9 nautical miles left or right of course. The OFFSET prompt is displayed on the INIT/REF INDEX page and in flight on the RTE page. Selection displays the LATERAL OFFSET (or ACT LATERAL OFFSET page if an offset already exists).

Some legs are invalid for offset. These include:

- End of flight plan waypoint
- Discontinuity
- Beginning of approach transition

- Approach procedure
- DME arc
- Heading leg
- Holding pattern (except PPOS)
- Certain legs containing flyover waypoints
- Course change greater than 135 degrees
- Preplanned termination waypoint.

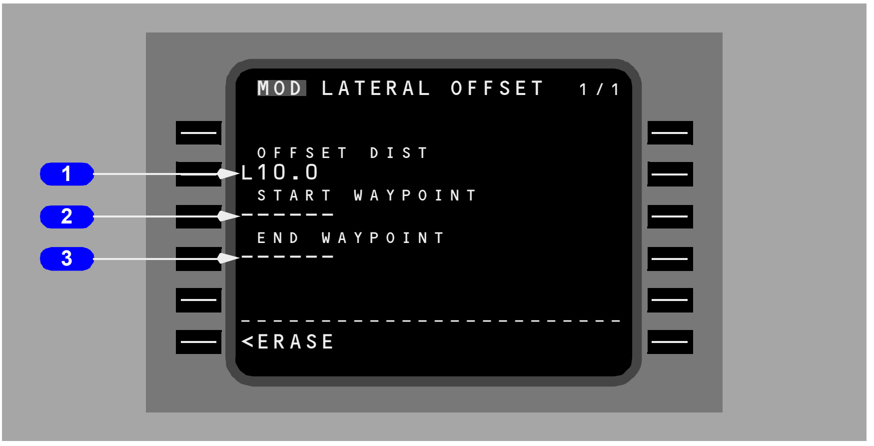


1 **OFFSET**

Push – displays the lateral offset page.

The offset prompt is only displayed when an ACTIVE or MODIFIED flight plan exists.

Lateral Offset Page



1 Offset Distance (OFFSET DIST)

The desired lateral offset distance is entered on line 2L In the example, the 10.0 nm offset left of course could be entered L10.0, L10, 10.0L, or 10L.

Entry results in display of start and end waypoint fields.

2 START WAYPOINT

The waypoint at which the offset is to begin may be entered (up to 6 characters).

Dashes are displayed if current leg is valid for offset. Box prompts are displayed if current leg is invalid for offset.

Offset will begin at first valid offset leg after the start waypoint.

Deletion of start waypoint (or no entry) will result in offset beginning at first valid offset leg in the flight plan.

3 END WAYPOINT

The waypoint at which the offset is to end may be entered (up to 6 characters).

Offset will propagate through flight plan until end waypoint is encountered.

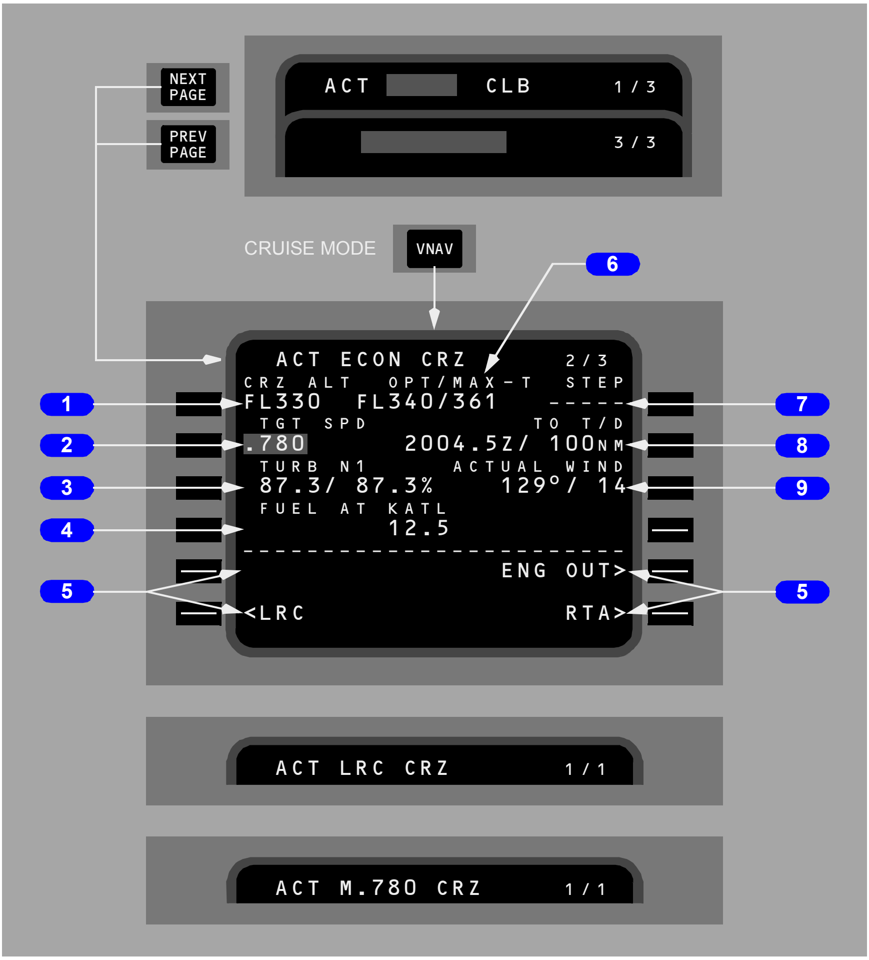
Deletion of end waypoint (or no entry) will result in offset propagating until an invalid offset leg is encountered.

VNAV Modifications

Three primary cruise modes are available – economy (ECON) cruise, long range cruise (LRC), and cruise with a manually selected speed.

Access to the various cruise pages is obtained by pushing the VNAV function key while in cruise. Access from other performance pages is via the NEXT/PREV PAGE key.

Cruise Page



1 Cruise Altitude (CRZ ALT)

Displays present cruise altitude in flight level or feet x 100. Value may be entered via the keyboard or propagated from the PERF INIT, CLB, CRZ CLB, or CRZ DES pages.

During active cruise, entry of a new value propagates to all other pages which display cruise altitude and causes the MOD CRZ CLB or MOD CRZ DES page to appear.

Value may be increased or decreased using altitude intervention.

2 Target Speed (TGT SPD)

The computed target speed displays one of the following:

- computed or manually selected value for target airspeed or Mach
- XXX/MCP when speed intervention is active and the plan is active
  •deletion or modification of XXX/MCP is not allowed
- XXX/HOLD when decelerating to hold speed prior to the hold entry fix
  •deletion or modification of hold speed is not allowed.

The value is reverse highlighted on an active cruise page.

Target Speed that would normally be displayed as “highlighted” for a non-color application, is displayed in magenta for color CDU’s on an active cruise page.

3 Turbulence N1 (TURB N1)

Displays proper N1 for turbulence penetration.

Value is for reference only. It is not commanded to the autothrottle.

4 Fuel at Destination (FUEL AT XXXX)

Displays the predicted fuel remaining at destination.

The value assumes continued flight per the displayed cruise and planned descent modes along the active route.

If a step to altitude is entered on line 1R, the computation assumes that the step will occur at the step point. After passing the step climb point, the predicted fuel weight is based on an immediate step climb from current position.

5 Cruise Page Prompts

Allow line selection of the various cruise pages.

The RTA prompt is replaced with ERASE when a MOD page is displayed.

6 Optimum/Maximum Altitude (OPT/MAX)

Displays the computed optimum altitude for the displayed cruise mode. The value is not constrained by minimum cruise time criteria (as is the TRIP ALT on the PERF INIT page).

Also displays the maximum possible altitude based on the selected target speed and the specified maneuver margin.

The limiting criterion for MAX altitude is labeled in the header.

- "- T" when available thrust is the limiting criterion for maximum altitude.
- "- B" when buffet margin is the limiting criterion for maximum altitude.

Maximum altitude reflects the altitude for the active or mod flight plan.

Values are advisory only. They are provided for crew reference.

7 Step to Altitude Line (STEP)

This line may be used to enter a possible step climb or descent altitude for crew evaluation.

The line will be blank when within 100 nm of top of descent or when RTA mode is active.

8 Top of Descent (TO T/D) Line

Displays time of arrival at and distance to top of descent point.

The data is always displayed when the distance is less than 100 nm. If the distance is more than 100 nm, the data will be displayed only if a step to altitude has not been entered.

9 ACTUAL WIND

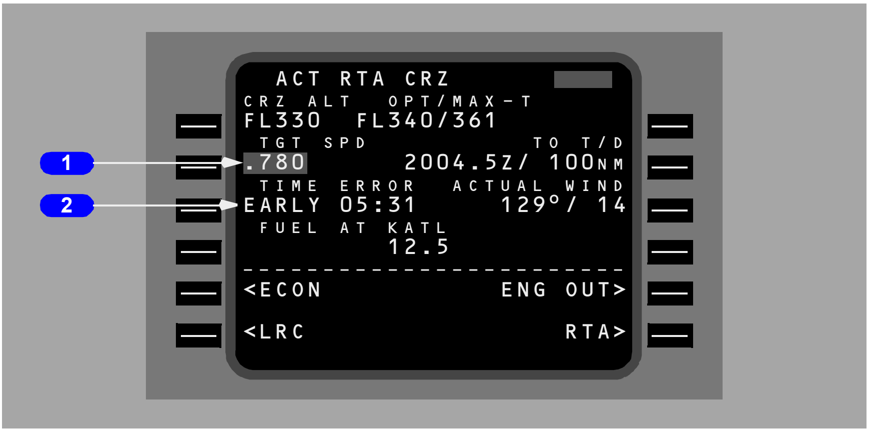
Displays computed or manually entered true wind for present altitude.

A manual entry has priority. The data line title then changes to EST WIND (estimated wind).

The displayed value is used as the assumed true wind at the step to altitude for making wind/altitude trade computations.

RTA Cruise

If an RTA waypoint has been specified, the cruise page will reflect the RTA data.



1 **Target Speed (TGT SPD)**

Displays the computed speed required to meet the RTA.

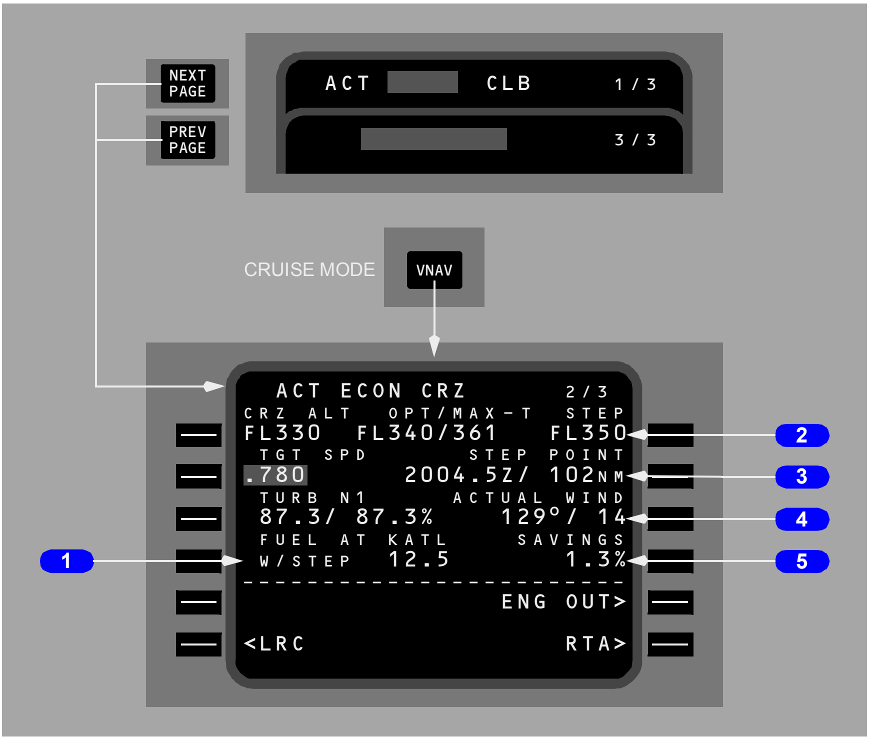
When RTA mode is exited by waypoint sequence or by deletion, this speed becomes the FMC target speed on a manual speed cruise page and the scratchpad message SELECT MODE AFTER RTA is displayed.

2 **TIME ERROR**

Displays the computed time error at the RTA waypoint.

Same as time error on RTA PROGRESS page.

Cruise with Step Climb



1 **Fuel at Destination with Step Climb Altitude (FUEL AT XXXX)**

The computation assumes the step climb will occur at the STEP point, and the value is prefixed by W/STEP.

2 **Step To Altitude (STEP)**

Used to enter step climb or step descent altitudes for crew evaluation.

Blank when within 100 nm of top of descent or when RTA mode is active.

3 **STEP POINT**

Displays the computed ETA at, and distance to, the first possible step climb point based on gross weight.

Blank if no entry on STEP TO line.

4 **Wind (ACTUAL WIND or EST WIND)**

Used as the assumed true wind at the STEP TO altitude for making wind–altitude trade computations.

5 **Savings/Penalty (SAVINGS or PENALTY)**

Displays the predicted cost savings or penalty associated with flying the displayed speed/altitude step climb or descent profile, as compared to flying the current cruise speed schedule and maintaining present altitude to top of descent.

Blank if no step data entered.

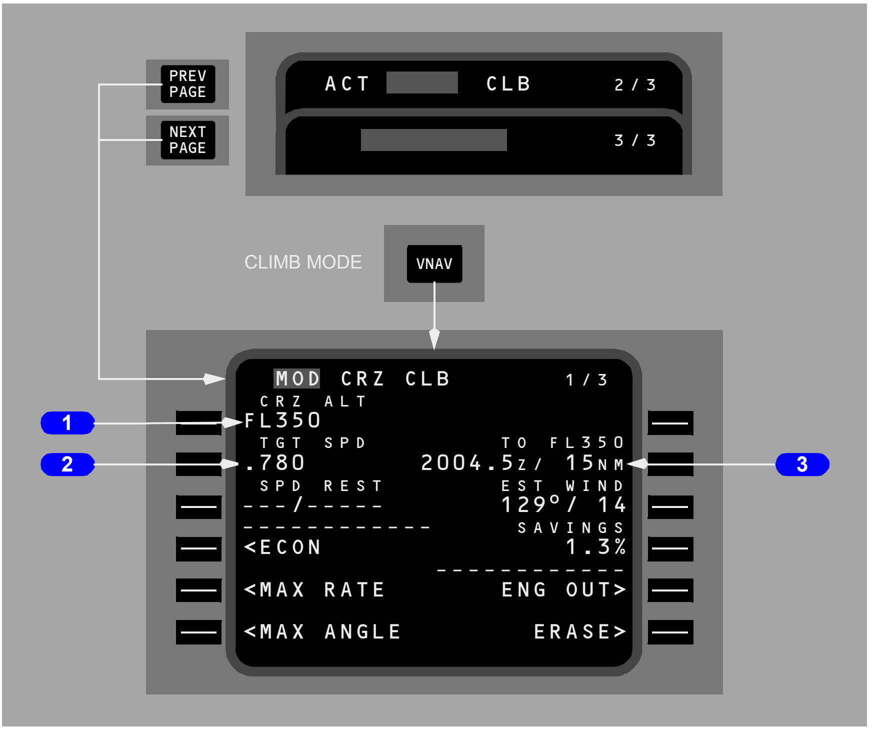
Cruise Climb

The cruise climb page displays data for a cruise climb to a new altitude.

MOD CRZ CLB is automatically displayed during cruise if a higher cruise altitude is entered on the CRZ page.

During VNAV operation, execution initiates a climb at climb thrust and cruise target speed to the new altitude.

The VNAV climb mode is active until reaching the selected altitude. The mode then automatically changes back to cruise.



1 **Cruise Altitude (CRZ ALT)**

Initially displays the CRZ ALT entered on the CRZ page.

Manual entry may be made.

2 Target Speed (TGT SPD)

Displays target cruise speed for the displayed cruise altitude.

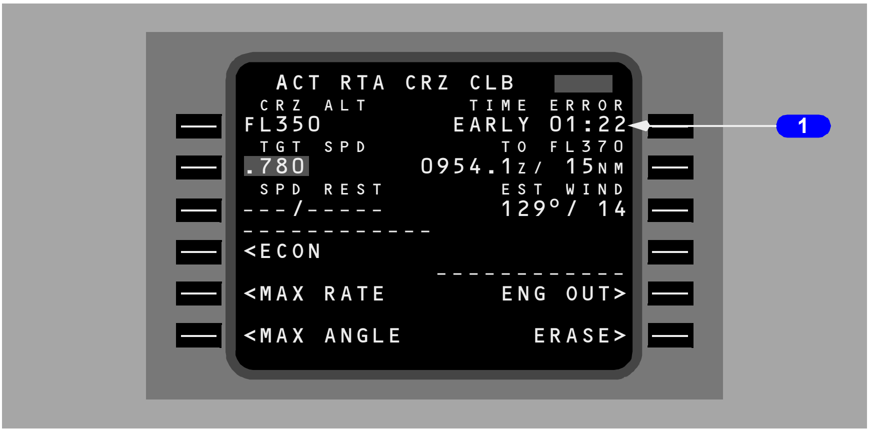
Manual entry may be made.

3 TO FLXXX

Displays ETA at, and distance to, the displayed cruise altitude.

RTA Cruise Climb

The RTA cruise climb page displays the same data as the cruise climb page except for the TIME ERROR line.



1 TIME ERROR

Displays the computed time error at the RTA waypoint.

Same as time error on RTA PROGRESS page.

Cruise Descent

The cruise descent page displays data for a cruise descent to a new altitude.

MOD CRZ DES is automatically displayed during cruise if a lower cruise altitude is entered on the CRZ page.

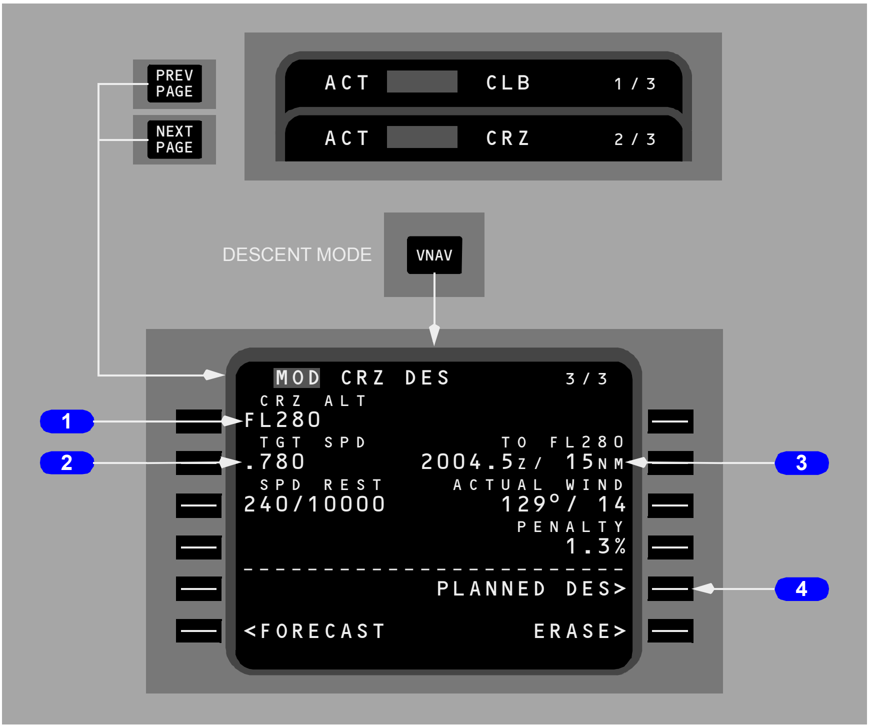
CRZ DES provides the means of initiating step descents to a new cruise altitude during cruise.

During VNAV operation, execution initiates a descent at 1,000 feet per minute and cruise target speed to the new altitude.

A CRZ DES will occur upon lowering the MCP ALT to a lower altitude, but at or above any descent constraint altitude and pressing ALT INTV if the airplane is further than 50 nm from the top of descent at the current cruise altitude, or by entering a new cruise altitude on the FMC CRZ page after setting the new level-off altitude in the MCP

The FMC software allows a CRZ DES to the normal Descent Path capture if the normal path is encountered during the Cruise Descent and prior to reaching the new cruise altitude. The active VNAV descent phase will be entered from a Cruise Descent at the time the extended descent path is captured.

Note: VNAV CRZ DES guidance at 1000fpm may not capture a new cruise altitude with sufficient distance to comply with any fix or waypoint altitude constraint if the fix or waypoint altitude constraint is the same as the new cruise altitude. Any fix or waypoint constraint that is the same as the cruise altitude may not be considered in the initial vertical trajectory. If initiating early descent, VNAV descent predictions will update the vertical path to include the fix or waypoint constraint.



1 Cruise Altitude (CRZ ALT)

Initially displays the CRZ ALT entered on the CRZ page.

Manual entry may be made.

With Speed/Altitude Intervention software, "CRZ ALT" can be decreased using altitude intervention.

2 Target Speed (TGT SPD)

Displays target cruise speed for the displayed cruise altitude.

Manual entry may be made.

3 TO FLXXX

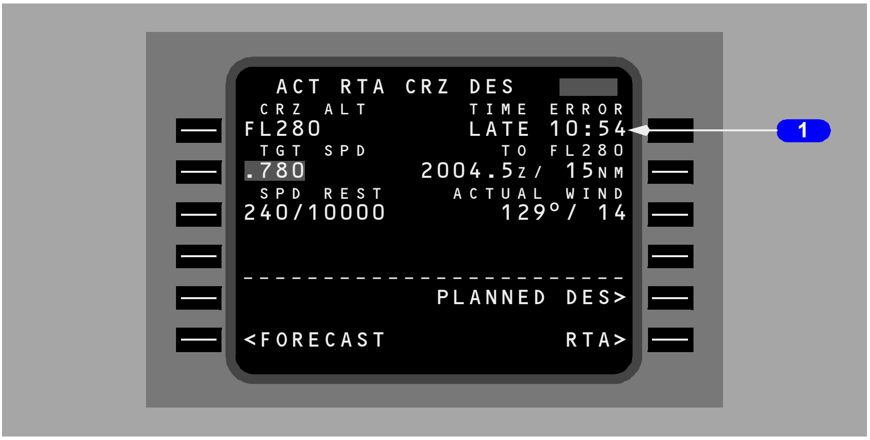
Displays ETA at, and distance to, the displayed cruise altitude.

4 Planned Descent (PLANNED DES)

Push – displays the planned DES page and allows access to the planned standard descent mode.

RTA Cruise Descent

The RTA cruise descent page displays the same data as the cruise descent page except for the TIME ERROR line.



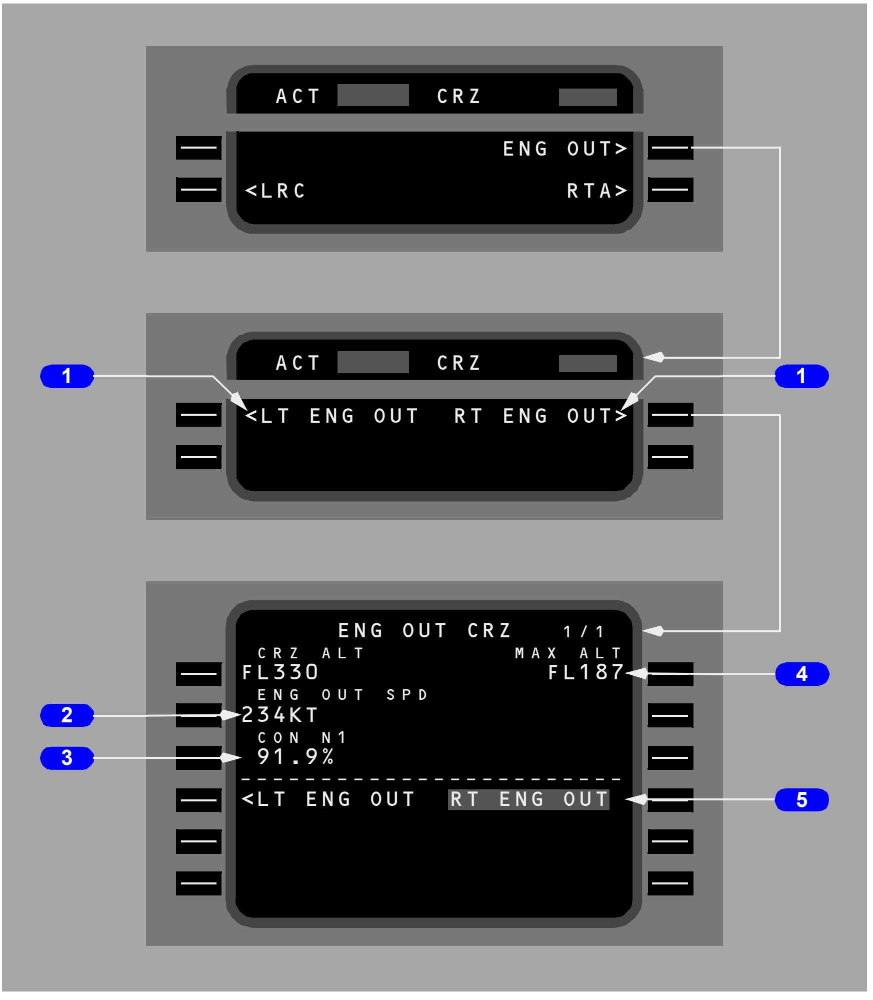
1 TIME ERROR

Displays the computed time error at the RTA waypoint.

Same as time error on RTA PROGRESS page.

Engine Out Cruise

The engine out cruise page may be accessed by selecting the ENG OUT prompt on the cruise page. The page displays advisory data for a one engine inoperative condition.



1 Left/Right Engine Out (LT ENG OUT/RT ENG OUT)

Selection changes display to ENG OUT CRZ page. The ENG OUT CRZ page is information only.

2 Engine Out Speed (ENG OUT SPD)

Displays the optimum speed based on minimum drag.

3 Continuous N1 (CON N1)

Displays N1 for maximum continuous thrust.

N1 is computed using actual bleed conditions.

4 Maximum Altitude (MAX ALT)

Displays the computed maximum altitude at which a company–specified rate of climb can be achieved, using one engine at maximum continuous thrust (default climb rate is 100 feet per minute).

After page selection, the FMC accounts for wing and engine anti–ice, air conditioning, and the engine bleed of the operating engine.

5 LT ENG OUT/RT ENG OUT

Selected engine is shown in reverse highlighting.

Early Descent

Early descents are initiated from the DES page. Once an early descent is executed, VNAV transitions to the descent mode and cruise features are no longer available.

For a path descent the DES NOW prompt will not be displayed until a descent path is established. Once executed, the autothrottle adjusts thrust to maintain 1000 feet per minute until intercepting the descent path.

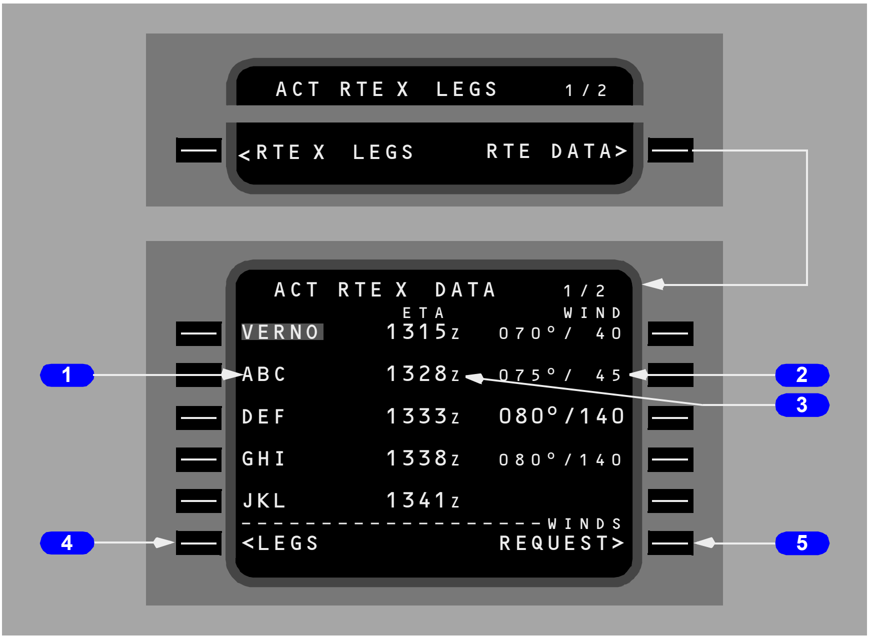
1 Descend Now (DES NOW)

Selecting the DES page before reaching the top of descent displays the normal descent page with the prompt DES NOW on the bottom right of the page. Selecting and executing the DES NOW prompt initiates a VNAV descent of 1000 feet per minute at ECON speed. Upon reaching the planned descent path, VNAV transitions to maintain the planned descent path.

Route and Waypoint Data
Route Data (RTE DATA) Page

The RTE DATA page displays ETA for each waypoint on the RTE LEGS page. This page also displays forecast wind data for cruise waypoints.

One page displays data for five waypoints.



1 Waypoint

Displays the identifier for the waypoint from the ACT RTE LEGS page.

2 WIND

Used for entry and/or display of the true winds at the cruise waypoint identified on the same line.

Entry may be via the keyboard, or propagated from the CRZ WIND entry on the PERF INIT page.

The CRZ WIND value (075°/45 is depicted) propagates to all cruise waypoints (ABC to GHI is the depicted cruise segment).

If no CRZ WIND entry was made, the FMC assumes 000°/000.

A keyboard entry has priority and propagates to all down path cruise waypoints (an entry of 080°/140) at DEF is depicted). The entry must be executed.

Any entries propagated from the CRZ WIND entry are displayed in small font. Keyboard entries are displayed in large font.

Crew entries of forecast winds (or default 000°/000) are automatically biased with the actual wind computed by the FMC when within 100 NM of a cruise waypoint and within 2000 feet of a cruise altitude. Biased values are not displayed.

Blank for non–cruise waypoints (VERNO and JKL are depicted). Entry is inhibited.

3 Estimated Time of Arrival (ETA)

Displays the FMC calculated waypoint ETA.

4 LEGS

Push – displays the RTE LEGS page.

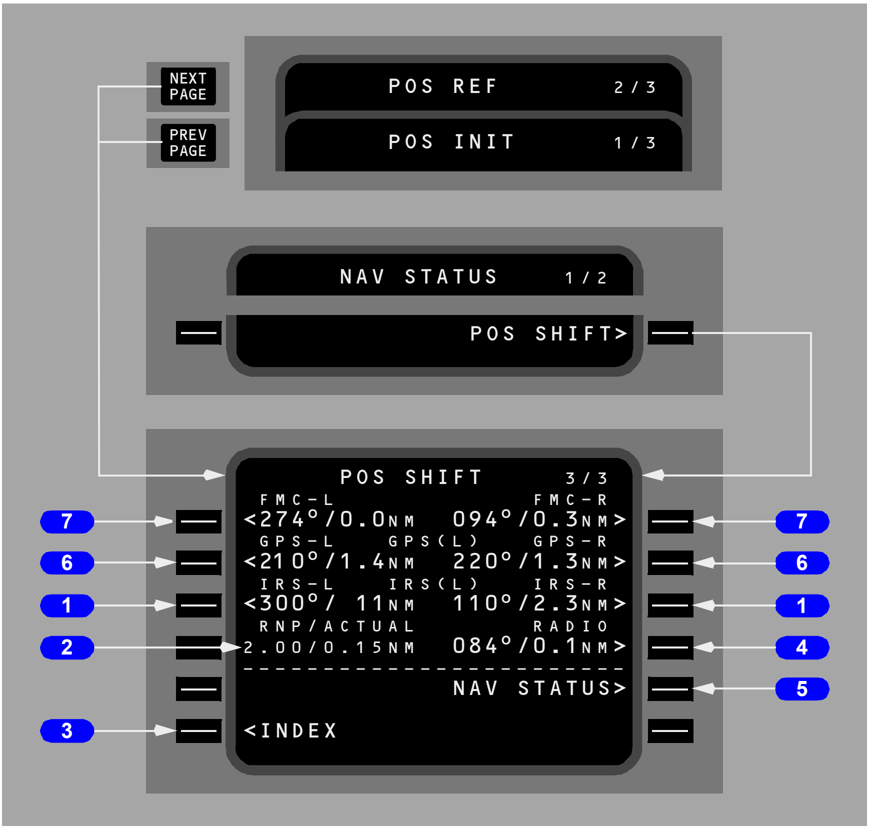
5 WINDS REQUEST

Push – transmits a data link request for winds uplink.

Position Shift Page 3/3

On the POS SHIFT page, each prompt indicates the bearing and distance of the indicated system relative to the FMC position. FMC position is displayed on line 1R of POS REF page 2/3. The entries with parentheses in the center of the page show the active position references.

Data fields are blank when on the ground.



1 IRS Position L/R

Displays left and right IRS position relative to FMC position using current mag/true reference. Blank if IRS position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

2 **Required Navigation Position/Actual (RNP/ACTUAL)**

Displays the required navigation accuracy compared to actual navigation accuracy.

Manual entry is allowed.

3 **INDEX**

Push – displays the INIT/REF INDEX page.

4 **RADIO Position**

Displays radio position relative to FMC position using current mag/true reference. Blank if radio position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

5 **Navigation Status (NAV STATUS)**

Push – displays the NAV STATUS page.

6 **GPS Position L/R**

Displays left and right GPS position (hybrid or raw) relative to FMC position using current mag/true reference.

Blank if hybrid and raw GPS position is invalid.

7 **FMC Position L/R**

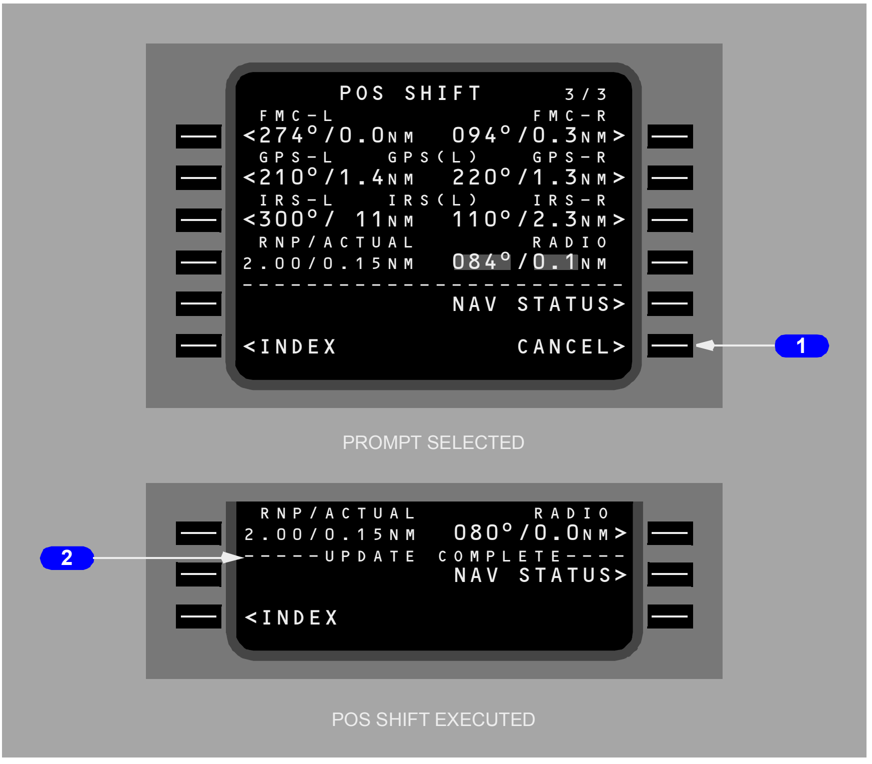
Displays left and right FMC position relative to FMC position using current mag/true reference. Blank if FMC position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

Inflight Position Update

FMC position update is accomplished on the POS SHIFT 3/3 page in flight. Selecting a prompt stops the updating of the relative position. The selection is highlighted, the associated caret is removed, the execute key is illuminated, and the CANCEL prompt is displayed in line 6R.

When the position shift is executed, UPDATE COMPLETE is displayed.



1 CANCEL

Displayed when a line selection is made for position update.

Push – prior to execution cancels the line selection.

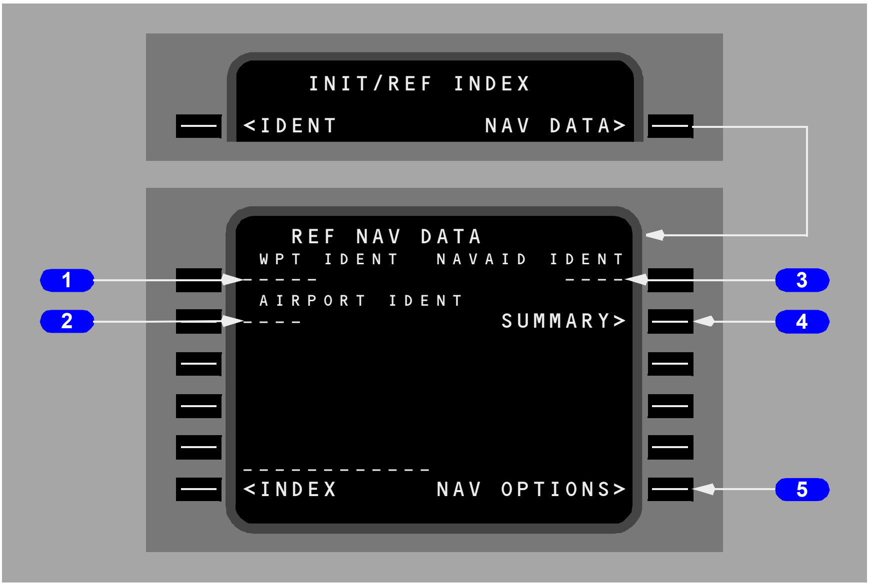
2 UPDATE COMPLETE

Displayed after a position shift has been selected and executed.

Navigation Data

Reference Navigation Data (REF NAV DATA) Page

The reference navigation data page provides information about waypoints, navaids, airports, and runways. Entering the appropriate identifier initiates the display. Writing SUPP in the scratch pad prior to selecting NAV DATA results in display of the supplemental navigation data (SUPP NAV DATA) page.



1 Waypoint Identifier (WPT IDENT)

Displays dashes initially.

Any waypoint, navaid or runway can be entered.

Format for runway entry is “RWnna” where “nn” is a one or two digit numeric (with or without leading zeros) and “a” is an optional character L, R, or C.

In order to access runway data, an airport must be identified.

2 Airport Identifier (AIRPORT IDENT)

Displays dashes initially.

Displays box prompts if runway is entered into 1L prior to airport entry.

An invalid airport/runway pair will result in “NOT IN DATA BASE” displayed in the scratchpad.

3 Navigation Aid Identifier (NAVAID IDENT)

Displays dashes initially.

Valid entries are up to 4 alphanumeric characters.

If the navaid is not contained in the databases, box prompts will appear in related data fields needing entry.

4 SUMMARY

Push – displays NAV SUMMARY pages.

Blank if supplemental and temporary databases are empty.

5 Navigation Options (NAV OPTIONS)

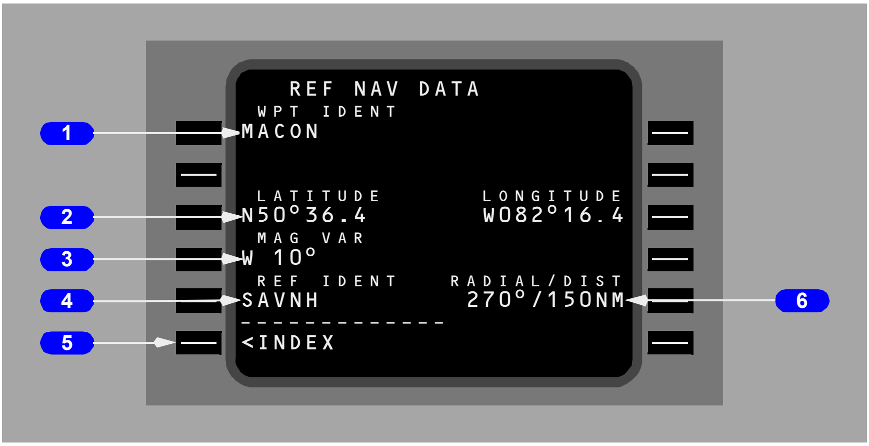
Push – displays NAV OPTIONS page.

If the entered identifier is already stored in the permanent, supplemental, or temporary database, then relevant data propagates to the subsequent REF NAV DATA display.

If the entered identifier is not stored in any database, the subsequent REF NAV DATA display contains box prompts. Following entry of the required information, the new data may be stored in the temporary database by executing (except for runway data). Data may be subsequently deleted from the temporary database by deleting the individual identifier, if the identifier is not presently being displayed on another page (e.g., RTE LEGS, PROGRESS, etc.).

All data stored in the temporary database is cleared at flight completion.

Waypoint Data Display



1 Waypoint Identifier (WPT IDENT)

Displays or permits entry of the desired waypoint. When this entry is complete, the associated data lines are displayed.

2 LATITUDE/LONGITUDE

Displays or permits entry of waypoint latitude and longitude. Entry on the REF IDENT and RADIAL/DIST lines cause latitude and longitude to be computed and displayed.

3 Magnetic Variation (MAG VAR)

Displays or permits entry of waypoint magnetic variation. Data is automatically computed based on latitude and longitude.

Manual entry has priority.

4 Reference Identifier (REF IDENT)

Together with RADIAL/DIST, displays or permits entry of reference point for a created waypoint.

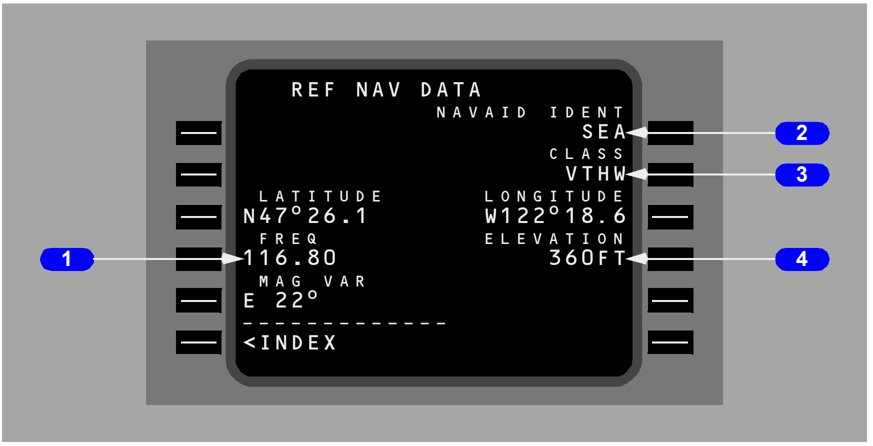
5 INDEX

Push – displays INIT/REF INDEX page.

6 Radial/Distance (RADIAL/DIST)

Together with REF IDENT, displays or permits entry of bearing and distance for a created waypoint.

Navigation Aid Data Display



1 Frequency (FREQ)

Displays or permits entry of the frequency of the entered navaid.

2 Navigation Aid Identifier (NAVAID IDENT)

Displays or permits entry of navaid identifier (5 characters maximum). Following entry, the associated data lines are displayed.

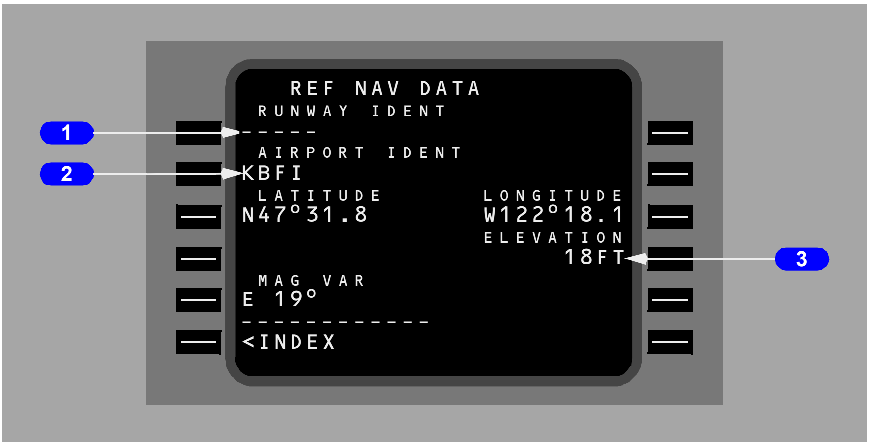
3 Classification (CLASS)

Displays or permits entry of the classification of the entered navaid.

4 ELEVATION

Displays or permits entry of the elevation (feet above MSL) of the entered navaid.

Airport Data Display



1 Runway Identifier (RUNWAY IDENT)

Permits entry of runway identifier.

2 Airport Identifier (AIRPORT IDENT)

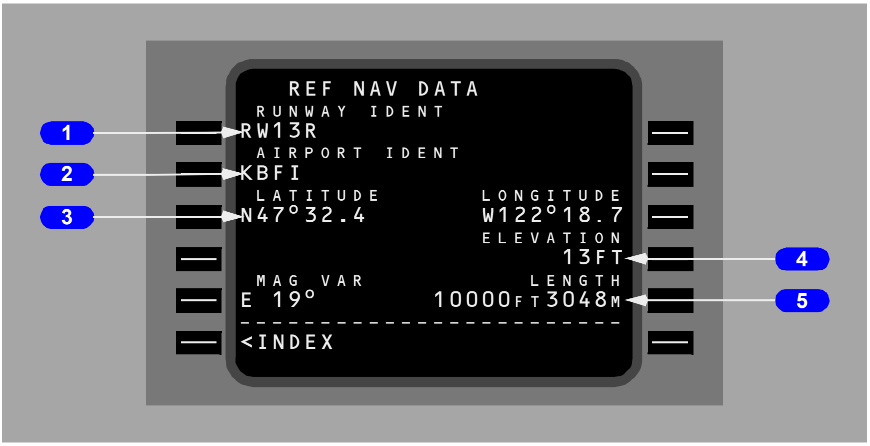
Displays airport identifier.

3 ELEVATION

Displays or permits entry of the elevation (feet above MSL) of the entered airport.

Runway Data Display

A runway identifier may be entered on the airport data display page or as a waypoint on the REF NAV DATA page. On the airport data display page, entry may be in the form of 13R or RW13R. Single digit entries are possible, with or without leading zeros.If the waypoint method is used, entry must be in the form RW13R, and the proper airport identifier must be entered on the runway data display page. Runways must be stored in the permanent navigation database.



1 Runway Identifier (RUNWAY IDENT)

Displays runway identifier.

2 Airport Identifier (AIRPORT IDENT)

Displays airport identifier.

3 LATITUDE/LONGITUDE

Displays latitude and longitude of entered runway.

4 ELEVATION

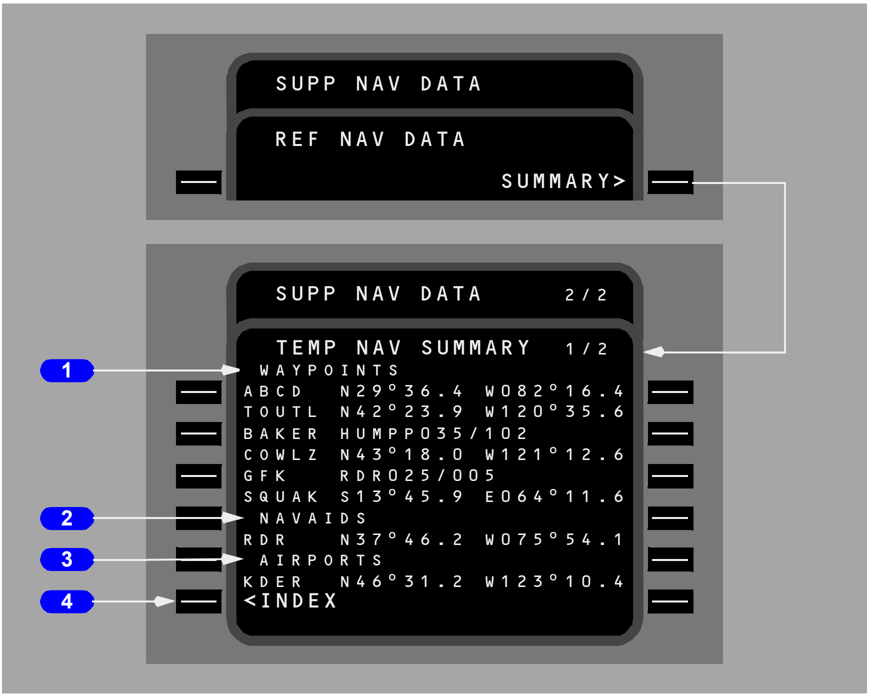
Displays elevation (feet above MSL) of the entered runway.

5 Runway Length (LENGTH)

Displays length of entered runway in feet and meters.

Navigation Summary (NAV SUMMARY)

The NAV SUMMARY pages show the contents of the temporary and supplemental navigation databases. Contents of the temporary navigation database show first, followed by contents of the supplemental navigation database.



1 WAYPOINTS

Shows waypoints stored in related database.

Waypoints show in defining format.

Waypoints may also be defined on the LEGS and RTE pages in either route as part of a flight plan.

2 NAVAIDS

Shows navaids stored in related database.

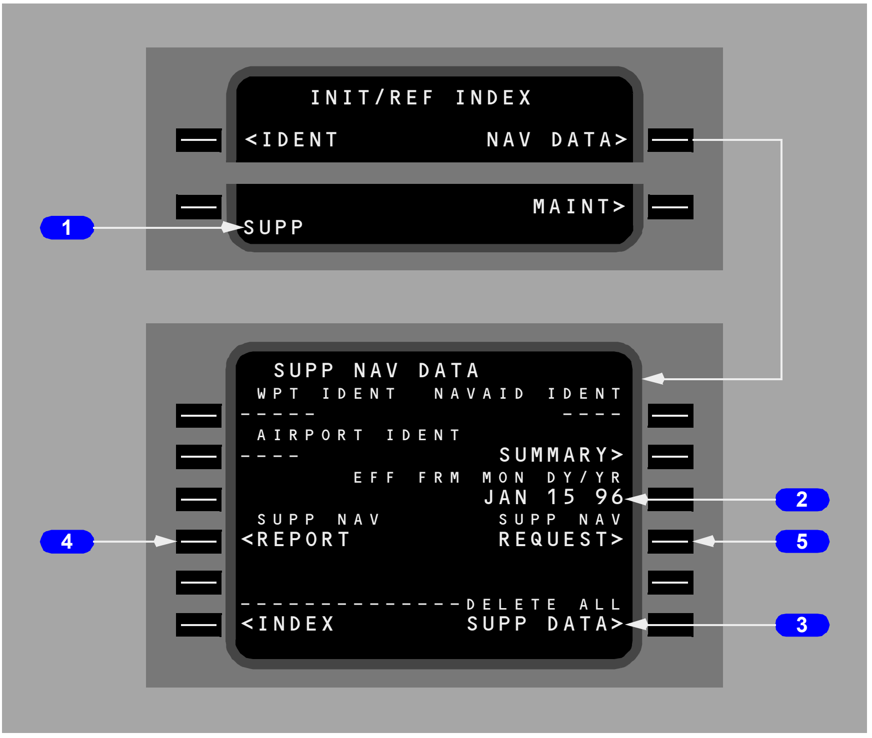
3 AIRPORTS

Shows airports stored in related database.

4 **INDEX**

Push – shows page (REF NAV DATA or SUPP NAV DATA) used to access NAV SUMMARY pages.

Supplemental Nav Data



1 **SUPP Scratchpad Entry**

The supplemental navigation database is accessed by typing SUPP in the scratchpad while on the INIT/REF INDEX page, then selecting the NAV DATA prompt. Access is only available on the ground.

2 **Effectivity Date (EFF FRM MON DY/YR)**

Allows entry of month, day, and year that the supplemental database becomes valid. The date will be displayed on IDENT page 1/2 after entry. Box prompts are displayed if an effectivity date is not entered.

3 **Delete All Supplemental Data (DELETE ALL SUPP DATA)**

Data may be deleted from the supplemental database by two methods. Deletion may be accomplished one item at a time on the display pages, or the entire database may be deleted by selecting this prompt. The prompt is only available before entry of an origin airport.

4 **SUPP NAV REPORT**

Push – transmits a copy of supplemental navigation database.

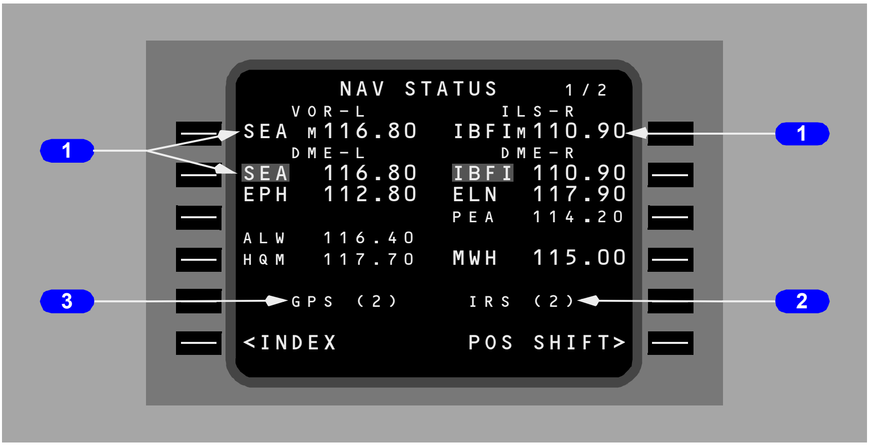
5 **SUPP NAV REQUEST**

Push – transmits a data link request for a supplemental navigation database uplink.

Navigation Status Display

The NAV STATUS page displays the current status of the navaids being tuned.

Access to the NAV STATUS display is from the NAV STATUS prompt on the POS SHIFT page 3/3, the PROGRESS page 1/5, and (in flight) the INIT/REF INDEX page or from the NAV OPTIONS page 2/2, NEXT or PREV PAGE.



1 **VOR/ILS and DME Lines**

Lines 1L and 1R display VOR or ILS identifier and frequency tuned on the corresponding VHF NAV control panel.

Lines 2L – 2R through 4L – 4R display up to five DME identifiers and frequencies tuned by the corresponding scanning DME receiver.

Data is displayed in large font with the identifier highlighted if that facility is being used for navigation.

Data is displayed in large font with the identifier not highlighted if that facility is being received but not used for navigation.

Data is displayed in small font if that facility is being tuned but not received.

If the navaid has failed, FAIL will be displayed in small font.

If there is no corresponding identifier for the displayed frequency, then the identifier field will be blank and only the frequency will be displayed.

On lines 1L or 1R, for VOR/ILS displays, the mode of tuning will be shown:

- M – Manual
- P – Procedural

On lines 2L – 2R through 4L – 4R, if no DME information is received then the identifier and frequency field is blank.

2 IRS Status Display

Displays the IRS currently selected for use in navigation. “L” or “R” indicates left or right IRS is being used in the FMC position calculation.

“2” indicates a dual system with both IRSs used in the FMC position calculation.

3 GPS Status Display

Displays the GPS currently selected for use in navigation. “L” or “R” indicates left or right GPS is being used in the FMC position calculation.

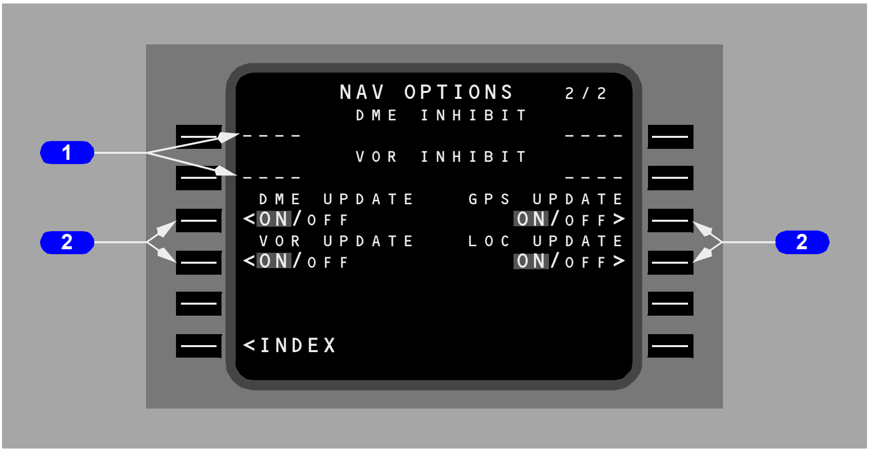
“2” indicates dual system with both GPSs used in the FMC position calculation.

The display will be blank if GPS is inhibited for use in navigation.

Navigation Options (NAV OPTIONS)

The FMC normally rejects the use of navaids that are not suitable for navigation. However, when the aircrew is aware that unreliable navaids exist (either by NOTAM, ATC, etc.) they should manually exclude these navaids from the FMCs navigation solution. This will prevent the possibility of incorrect position calculations and maximize the FMCs reliability. This is accomplished through the NAV OPTIONS page.

Access to the NAV OPTIONS page may be gained by selecting the NAV OPTIONS prompt on the REF NAV DATA page or by selecting NEXT or PREV PAGE on the NAV STATUS page.



1 DME/VOR INHIBIT

Enter the identifier of up to two VOR/DME, VORTAC, or DME stations that must not be used for FMC position updates.

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

The FMC normally uses DME from two different ground stations to update its position solution. When two DME stations are not available, the FMC reverts to single station radial-DME updating to determine position. Only two of the four inhibit entries are utilized at any one time depending upon which update mode the FMC is operating in. The DME INHIBIT entries are excluded from the FMCs update solution whenever the FMC is updating from two DME stations. The VOR INHIBIT entries are excluded from the FMCs update solution whenever the FMC is radial-DME updating.

2 **DME/VOR/GPS/LOC UPDATE**

Push – permits switching between ON and OFF modes for updating FMC position. Default mode is ON for VOR, GPS and LOC. DME defaults to OFF. The current mode is highlighted.

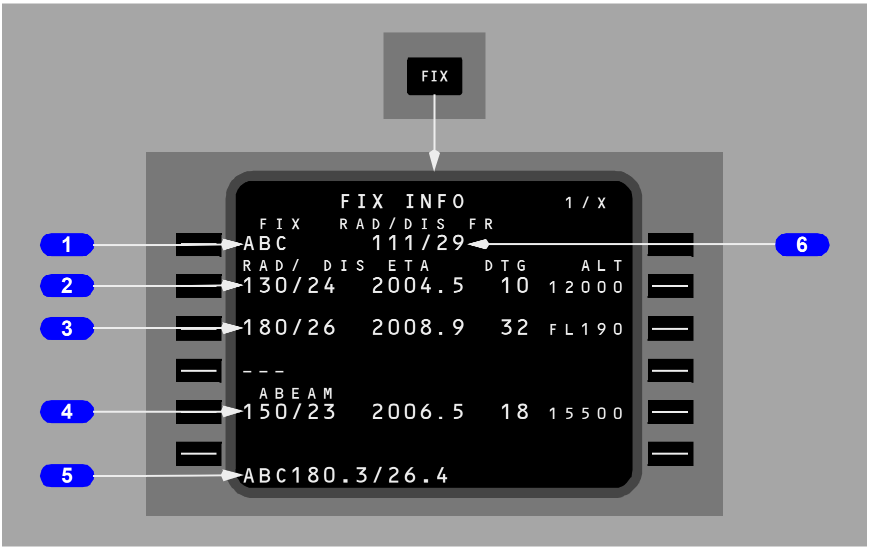
Note: When the DME UPDATE is OFF, the VOR-DME and LOC-DME UPDATES are also inhibited even if the VOR and LOC UPDATES are selected ON. If the FMC hasn't done a GPS UPDATE in the last 5 seconds then the FMC can do a LOC only UPDATE without DME if the LOC UPDATE is selected ON and the DME UPDATE is selected OFF.

Selections are reset to ON at flight completion except for DME which is reset to OFF.

Fix Information Page

Two identical FIX INFO pages are used to identify waypoint fixes for display on the navigation display map mode. If desired, fix information can be copied into the route. Page access is via the FIX key.

Radial or distance entries from the fix may be made on any line 2L to 4L. Valid format is a three character numeric entry. Slash rule is used to differentiate between radial and distance in the scratch pad.



1 **FIX Name**

Enter the desired fix.

Valid entries are airports, navaids, waypoints or runway identifiers from the navigation database.

The selected fix is displayed on the navigation display map mode and highlighted by a green circle.

2 Distance Entry (example)

Enter a distance from the fix. Distances from the fix are displayed on the navigation display map mode as a dashed green circle around the fix.

When the distance intersects the active route, the ETA, DTG, and predicted altitude at the intersection are displayed for that intersection.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

Valid entries are xxx.x:

- distance is limited to 999 NM or less and may contain 1/10 NM entry
- leading zeros can be omitted for distance
- decimal values can be omitted
- distance only entries must start with a /.
- entries of 512 NM or greater will appear as 512 NM on the ND, but data displayed on the CDU will match the range entered on the CDU of 512 NM or greater

ETA – displays the estimated time of arrival to the intersection point.

DTG – displays the distance to go to the intersection point.

ALT – displays the predicted altitude at the intersection point.

3 Radial Entry (example)

Enter a radial from the fix. Radials are displayed on the navigation display map mode as green dashed lines from the fix.

When the radial intersects the active route, the ETA, DTG, and predicted altitude at the intersection are displayed.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

Valid entries are xxx or xxx/.

4 ABEAM

Displays the abeam point and calculates the ETA, DTG, and ALT information.

The fix abeam point ahead of the airplane is displayed by a radial line from the waypoint ending at the nearest perpendicular route leg intersection.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

5 Route Intersection Point Copied

Pushing the line select key for one of the RAD/DIS entries copies the fix place/bearing/distance definition into the scratchpad. This fix can be placed into the route on a LEGS page as a waypoint.

6 Radial/Distance From Fix (RAD/DIS FR)

Displays the radial and distance from the fix to the airplane. This information is continually updated as the airplane position changes.

Introduction

The descent phase begins at the top of descent point and continues to the end of descent point. Planning for the descent phase begins during cruise.

The approach phase begins at the end of descent point and continues to touchdown or go–around. When a go–around is accomplished, the FMC enters the cruise phase.

The only automatic page change provided in the descent/approach modes is the transition from cruise to descent at the top of descent.

Early Descent

Early descent may be commenced prior to reaching the top of descent by using the DES NOW prompt.

A CRZ DES occurs when lowering the MCP ALT to a lower altitude while at or above any descent constraint altitude and pressing ALT INTV. The airplane must be further than 50 nm from the Top of Descent (T/D) at the current cruise altitude. If within 50 nm of the top of descent, the Early Descent mode will be invoked.

- A cruise descent can be started by using the altitude intervention feature on the MCP when the airplane is not within a distance of 50 NM to the T/D, or by entering a new cruise altitude on the FMC CRZ page after setting the new level-off altitude in the MCP.
- Altitude Intervention may be used to initiate Early Descent when the airplane is 50 nm or less fromT/D.
- If Altitude Intervention is used to initiate descent when 50 NM or less to T/D and the MCP ALT below current altitude, or descent is initiated via DES NOW prompt on the DES page, Early Descent vertical speed commands of -1000 fpm are generated by the FMC for autopilot V/S tracking until path intercept, or next constraint altitude if altitude is reached when VNAV is engaged, or MCP ALT level off occurs.
- If Altitude Intervention is used to initiate descent when more than 50 NM to T/D with VNAV engaged and the MCP ALT below current altitude but at or above any descent constraint altitude, the result will be cruise altitude reset to the MCP ALT and Cruise Descent vertical speed commands of -1000 fpm to the new cruise altitude.
- If Altitude Intervention is used to initiate descent when more than 50 NM to T/D with VNAV engaged and the MCP ALT below current altitude and below a descent constraint altitude, the result will be Early Descent vertical speed commands of -1000 fpm until path intercept or MCP ALT level off occurs.

Descent

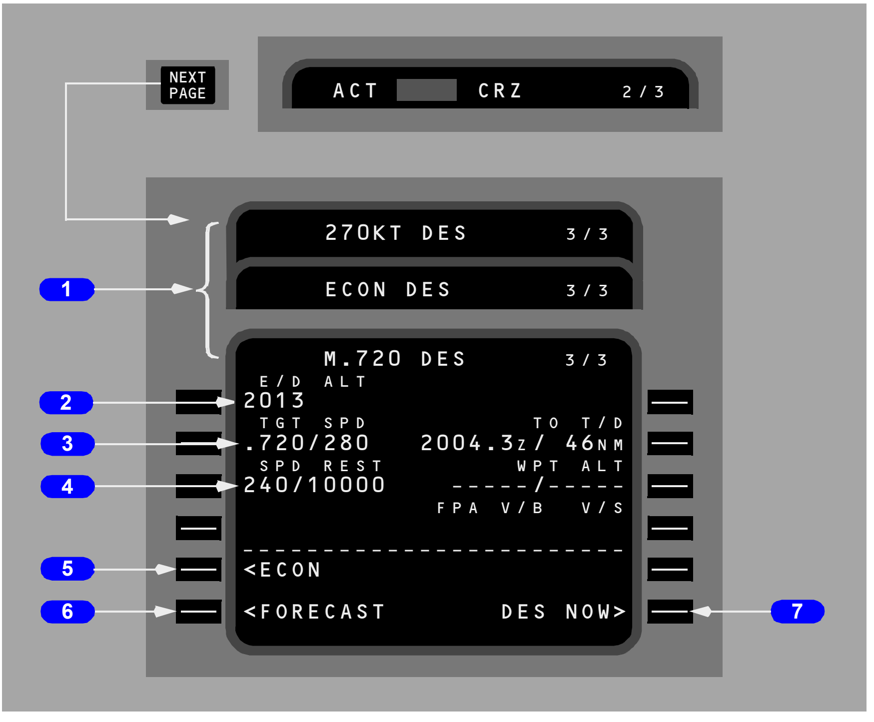
During descent, LNAV progress is managed using the RTE LEGS and PROGRESS pages, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

The DES FORECASTS page is also available to enter forecast wind data to aid in descent planning.

Descent Page (During Cruise)

The descent page is used to monitor, revise, or select the descent path. Descent modes are economy (ECON) path and manual path and speed. The default VNAV descent mode is ECON path. The crew must select a manual speed descent mode.

The page title reflects the type of VNAV path descent. The path mode controls descent to fly a vertical path which complies with altitude and speed restrictions in the flight plan.



1 Page Title

The page title identifies the selected mode. When a manual speed is selected, the title includes XXXKT for fixed CAS or M.XXX for fixed Mach selections.

Displays ACT when the descent phase is active.

2 End of Descent Altitude (E/D ALT)

Displays the end of descent altitude.

- for a DES page, displays the altitude restriction for the E/D waypoint, blank if a path descent is not available
- if an approach is selected which ends at RWXXX, the E/D altitude will be Threshold Crossing Height (TCH), 50 feet above the runway.

The end of descent altitude is the altitude constraint or predicted altitude of the last descent waypoint. End of descent may follow a lateral discontinuity. If a lateral discontinuity exists, the FMC will construct a great circle path across the discontinuity and VNAV shall be valid while flying the discontinuity.

3 Target Speed (TGT SPD)

Displays the command speed maintained by VNAV while descending to waypoints, constraints, or speed restrictions.

Displays XXX/MCP when speed intervention is active.

The ECON DES page displays the computed values for target Mach and airspeed. Speeds are performance limited.

Blank for any DES page if a path descent is not available.

4 Speed Restriction (SPD REST)

Displays the most restrictive of the following speeds:

- speed restrictions at the destination airport minus 10 knots
- waypoint speed restriction if greater than minimum flaps up maneuvering speed
- minimum flaps up maneuvering speed
- selected Vref + wind correction for landing flap setting
- whenever flaps are extended, the, appropriate flap speed shall be displayed as XXX/FLAPS. This shall supersede any other speed restriction
- displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

Dash prompts displayed when there is no active speed restriction.

Manual crew entries or deletions may be made. HOLD or FLAPS speed may not be deleted or modified.

5 Economy (ECON)

Displayed on the manual DES pages.

Push – selects the corresponding ECON DES page.

6 Descent Forecasts (FORECAST)

Push – selects the DES FORECASTS page.

7 Descend Now (DES NOW)

Displayed on the standard DES pages whenever descent is not ACT or MOD.

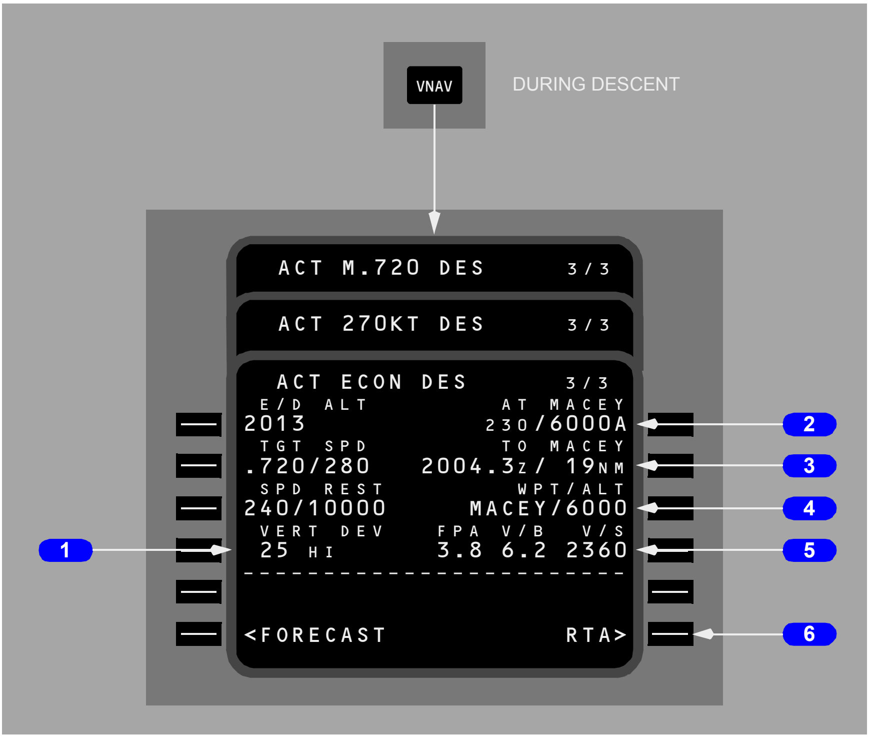
Blank for any DES page if a path descent is not available.

Push – arms the DES NOW function and illuminates the EXEC light.

On a DES page, execution allows early initiation of a path descent at 1000 fpm until intercepting the computed path.

Descent Page (During Descent)

Display when any descent mode is active after beginning of descent.



1 Vertical Deviation (VERT DEV)

Displays present deviation (feet HI or LO) from the computed vertical path.

The deviation is always in relation to the path descent profile.

Blank if a path is not available.

2 Altitude Restriction (AT XXXXX)

Displays the next waypoint constraint from the RTE LEGS page.

The constraint is speed/altitude. If an airspeed restriction exists at the waypoint, it will be displayed in large font; otherwise the predicted speed will be displayed in small font.

Can be deleted on this page.

The display is blank when no constraint exists, or for any DES page if a path descent is not available.

3 To Waypoint (TO XXXXX)

Displays computed ETA and distance to go to T/D when not in an active descent mode.

If an early descent is in progress (initiated using DES NOW prompt), ETA and distance to go to original T/D is displayed until passing the T/D.

If a descent mode is active, displays ETA and distance to go to the first of the following points:

- the waypoint in the AT XXXXX line
- an intermediate T/D (TO T/D – XXXXX, where XXXXX is the altitude).

The display is blank if a path descent is not available, or if the AT XXXXX line is blank and no T/D information is displayed.

4 Waypoint/Altitude (WPT/ALT)

Displays the waypoint and altitude that serves as the basis for the vertical bearing (V/B) display on line 4R.

Normally displays the same waypoint/altitude restriction that is displayed on the AT XXXXX line.

May be overwritten by pilot entry.

A runway identifier may be entered for a runway at the destination airport of the active flight plan. Format may be either RWXX/, RWXXX/, RWXX/AA, or RWXXX/AA where XX or XXX is the runway designation and AA is the altitude. When RWXX/ or RWXXX/ is used the altitude will automatically be set to runway elevation plus threshold crossing height.

Dash prompts are displayed if there is no entry.

5 **Vertical Path Parameters (FPA V/B V/S)**

Displays the following parameters related to the present vertical path:.

- FPA – actual flight path angle based on present ground speed and vertical speed (that is, the present vertical bearing being flown)
- V/B – vertical bearing direct from present position on the WPT/ALT line (that is, the flight path angle required if flying direct to the waypoint and altitude on the WPT/ALT line).
- V/S – the required vertical speed (in fpm, based on present ground speed) to fly the displayed V/B.

Blank if no entry on the WPT/ALT line.

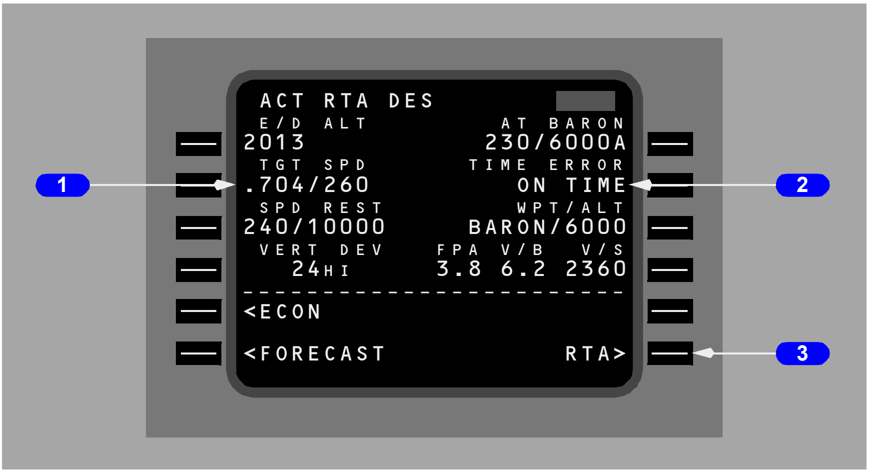
6 **RTA**

Displayed when DES NOW or ERASE prompt is not displayed.

Push – selects the RTA PROGRESS page.

RTA Descent Page

RTA Descent pages are displayed when an RTA mode is active. Displays are the same as on other descent pages except as noted.



1 **Target Speed (TGT SPD)**

Displays computed RTA target speed.

Changes to FMC target speed if the RTA mode is exited.

2 **TIME ERROR**

Displays computed time error at the RTA waypoint.

Same as time error line on RTA PROGRESS page.

3 RTA

Push – selects the RTA PROGRESS page.

Descent Forecast Page

The descent forecast page is used for pre–descent planning to enter forecast data for more precise descent path calculation.

The primary entries are wind direction and speed for up to three descent altitudes, and the altitude that anti–icing is turned on and off.

1 Transition Level (TRANS LVL)

Normally displays FL180 as the assumed descent transition level.

Changes automatically when entering flight plan data based on the following criteria if a pilot entered value has not already been entered:

- the FMC will use the transition level from the NDB stored for the STAR or terminal approach record if the flight plan is active, a STAR or terminal approach has been selected and the transition level exists for the STAR.
- if an active flight plan exists and no transition level exists on the STAR or terminal approach NDB record or a STAR or terminal approach has not been selected, then the FMC will use the transition level from the NDB stored for the DESTINATION airport.

- if there is no trans level for the DESTINATION airport in the NDB for the conditions defined above, then the default transition level will default to the transition altitude from the NDB stored for the DESTINATION airport.
- if the transition level is not available from any of the sources above, then the FMC will default the transition level to 18000 feet or the value contained in a loaded custom performance defaults data base.

Manual entry allowed and takes priority.

Data may be up-linked via ACARS message. The up-linked value will appear in small font until EXECuted at which time it will be displayed in large font.

2 CABIN RATE

Displays the predicted cabin rate of descent required by the active flight plan descent profile.

3 Descent Wind (ALT – – – – – WIND – – – – DIR/SPD)

Allows entry of altitude and wind direction/speed for up to three forecast wind values.

Entries may be made in any altitude sequence and will be automatically ordered by altitude from highest to lowest.

Data may be up-linked via ACARS message. The up-linked value will appear in small font until EXECuted at which time it will be displayed in large font.

4 Thermal Anti–Ice On/Off (TAI ON/OFF)

Enter the altitudes in flight level or feet at which anti–ice is expected to be turned on and off.

Data may be up-linked via ACARS message. The up-linked value will appear in small font until EXECuted at which time it will be displayed in large font.

5 ISA Deviation and QNH (DEV/QNH)

Enter the average ISA deviation for descent in °C (+/–XX°C) or °F (+/–XX°F)

Enter the destination QNH altimeter setting (IN. HG. or MB). Do not enter a QFE altimeter setting.

Data may be up-linked via ACARS message. The up-linked value will appear in small font until EXECuted at which time it will be displayed in large font.

6 ERASE or LOAD

Push – (ERASE) deletes modification and returns page to previously displayed descent page.

Push – (LOAD) initiates the loading of ACARS up-linked descent forecasts data.

LOAD is displayed when ACARS descent forecasts has the highest load priority and no EXECutes or ACCEPT/REJECTs are pending.

7 DES WINDS REQUEST

Push – transmits a data link request for descent winds.

Engine Out Descent

There are no specific engine out pages for descent. Use the normal descent planning features and pages.

Approach

During approach, LNAV and VNAV guidance normally transitions to the approach guidance provided by navigation radios. The FMC continues to calculate and display present position and can provide LNAV and VNAV approach guidance for certain types of approaches when radio navigation is not used.

The RTE LEGS and PROGRESS pages are used to manage the airplane until other approach guidance becomes active. Other pages which support approaches are:

- APPROACH REF page – to select the approach VREF
- ARRIVALS page – to select the desired arrival and approach procedures
- HOLD page – to manage holding patterns.

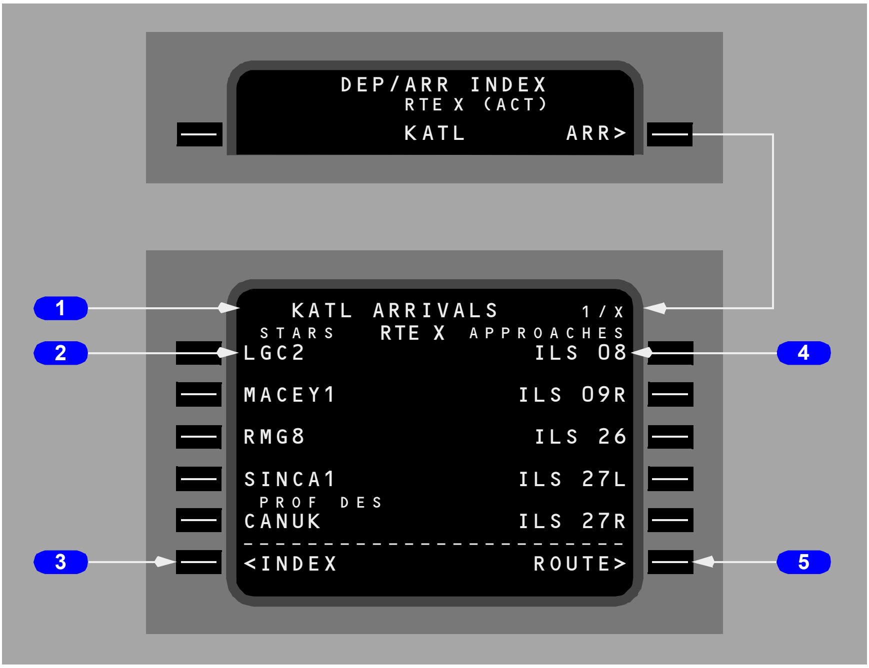
Holding is described in this section but it can be used during any phase of flight.

Arrivals Page – IFR Approaches

The arrivals page allows selection of an approach, standard terminal arrival route (STAR), and arrival transitions to the destination airport. This page can also be used to view information about a selected airport that is not the destination. Only procedures for the origin and destination airport can be selected for entry into the flight plan.

The approaches, STARS/profile descents, and transitions are displayed and selected on this page.

With Route 2 software the ARRIVALS page will designate which route the displayed arrivals are for by placing a RTE 1 or RTE 2 at the top center of the ARRIVALS page.



1 Page Title

The destination airport identifier is displayed in the title.

Airports with more than 5 runways or STARs produce multiple arrivals pages.

2 Standard Terminal Arrival Routes (STARS)

Upon initial selection, an alphabetical listing of all STARS and profile descents is displayed.

STARS are displayed first in a list under the STAR label. Profile descents are listed after the STARS under the PROF DES label.

Selection of the desired STAR deletes all other STARs and non–applicable approaches/runways, and displays a listing of any arrival transitions applicable to that STAR.

The selection of an approach or runway deletes all STARs not related to that approach/runway.

3 INDEX

Push – displays the DEP/ARR INDEX page.

4 Approaches and Runways (APPROACHES)

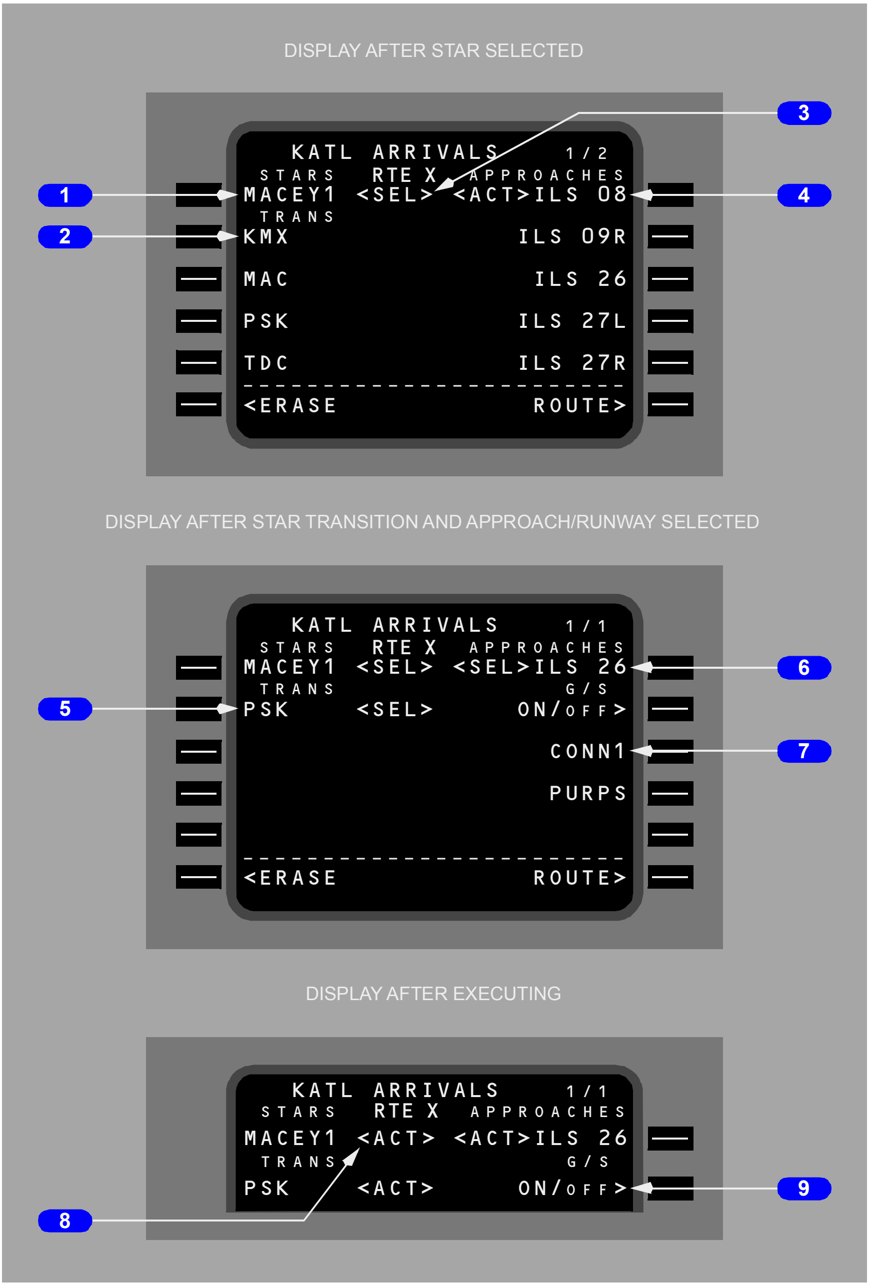
Upon initial page display, an alphabetical listing of all approaches for the airport, followed by a numerical listing of all runways, is displayed.

Selection of the desired approach or runway deletes all other approaches/runways.

5 ROUTE

Push – displays the RTE page.

Arrivals Page during approach selection



1 STARS

Displays the selected STAR.

2 Arrival Transitions (TRANS)

Displays all arrival transitions related to the selected STAR.

3 Selected Status Label (<SEL>)

Identifies arrival/approach procedures or a runway which has been selected for entry into the route, but not executed.

All <SEL> entries propagate to the MOD RTE and MOD RTE LEGS pages for subsequent execution.

4 Approach and Runway (APPROACHES, RUNWAYS)

Displays all approaches related to the selected STAR, followed by all related runways (unless the desired approach/runway was selected on the initial display).

5 Arrival Transition (TRANS)

Displays the selected arrival transition.

6 APPROACHES

Displays selected approach/runway.

7 Approach Transition (TRANS)

Displays all approach transitions related to the selected approach.

8 Active Status Labels (<ACT>)

Following execution of the selected entries, the arrival/approach procedures and runway are identified as active.

Note: For an existing active route, the execute key illuminates upon STAR or approach/runway selection. Following selections, the ERASE prompt is available. Selections should be executed on the RTE or RTE LEGS pages after linking any route discontinuities.

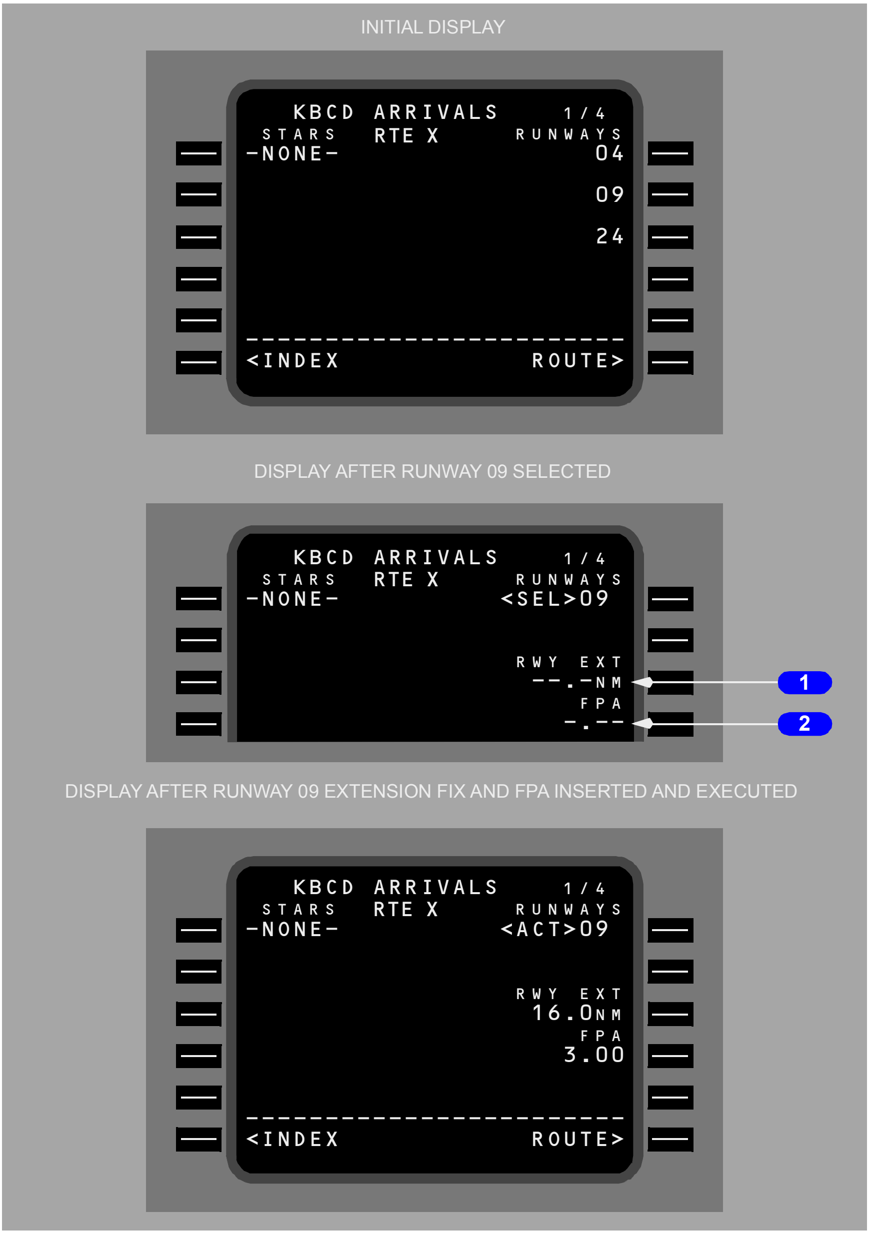
9 Glideslope (G/S)

Toggles glideslope ON and OFF for the selected or active approach.

When an ILS or IGS approach is selected in the FMC, G/S defaults to ON.

When a LOC, SDF, LDA or BCS approach is selected in the FMC, G/S defaults to OFF.

Arrivals Page – Runway Extension Fix and Flight Path Angle



1 Runway Extension (RWY EXT)

Permits optional entry of a runway extension waypoint following selection of desired runway.

Desired extension distance is entered in scratch pad, then inserted on RWY EXT line. Valid entries are between 1 and 25 NM (.1 NM resolution). This creates a waypoint on the extended runway centerline at the specified distance from the runway threshold.

Waypoint is identified on the RTE and RTE LEGS pages as RX–YYY, where YYY is the runway designation.

A speed/altitude constraint may be entered for the RWY EXT fix from the RTE LEGS page.

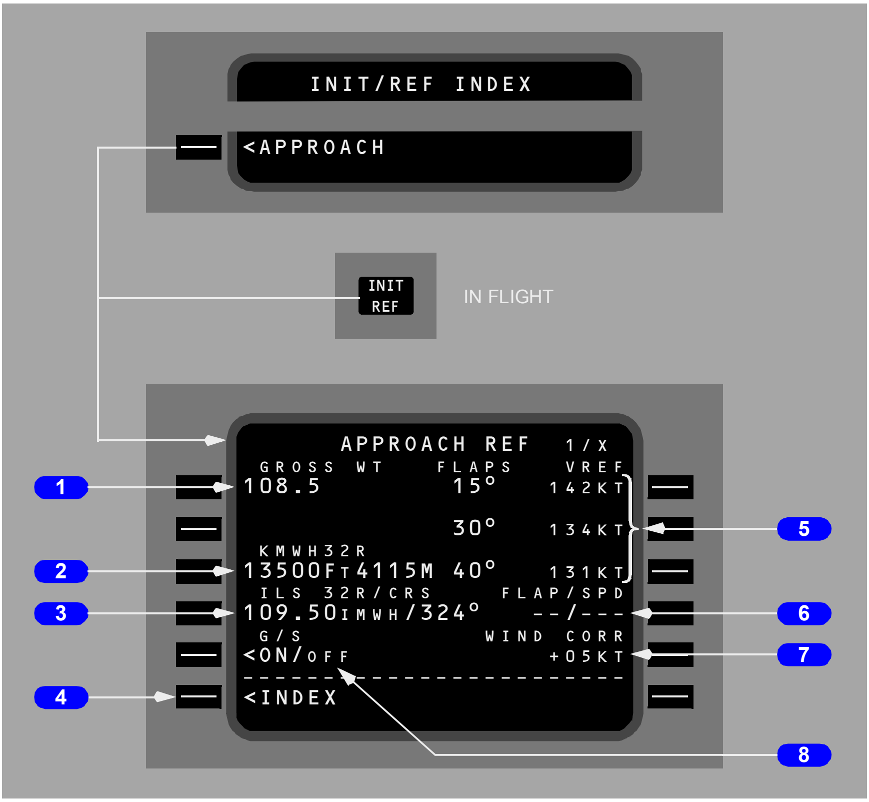
2 Flight Path Angle (FPA)

Permits optional entry of a flight path angle between the runway threshold and the runway extension fix. Default is 3.0 degrees. Valid entries are from 2.0 to 5.5 degrees.

Note: Dashes (–.– –) are displayed on the DEP/ARR page when the default is used.

Approach Reference Page

The approach reference page displays approach planning information and approach reference speed (VREF) selection. The displayed data is for the DEST airport and the arrival/ approach entered into the FMC flight plan.



1 Airplane Gross Weight (GROSS WT)

Normally displays the FMC calculated airplane gross weight.

A manual entry of gross weight is allowed.

Displays box prompts when gross weight is not available from the FMC.

Valid entry is XXX.X.

Leaving and returning to this page replaces a manually entered weight with FMC computed gross weight.

2 Runway Length

Displays the length in feet and meters of the referenced runway.

Blank if no runway has been entered and executed.

3 **Approach Information**

Displays the runway number, associated ILS frequency (GLS channel) and approach identifier for the ILS, LOC, LDA, SDF, GLS or back course approach in the active flight plan.

Displays front course in large font, if a localizer based or GLS based approach is displayed on 4L. If the course is true displays is suffixed with “T”.

Blank if no localizer or GLS based approach has been executed.

4 **INDEX**

Push – selects the INIT/REF INDEX page.

5 **Vref (FLAPS – – – VREF)**

Displays landing Vref for three flap settings as computed by the FMC. Displayed in small size characters.

Selection causes the flap and VREF speed to be placed in 4R.

Double line selection of a displayed Vref, or manual entry of another value, causes the flap and VREF speed to be placed in 4R and causes Vref to be displayed on the airspeed display. CDU display changes to large size characters.

Speeds are based on displayed gross weights.

Double line selection provides Vref to be used by VNAV in combination with wind correction.

Vref, once selected, will not be updated. To obtain an updated speed, the current speed must be deleted or a different Vref selected or entered.

6 **Flap/Speed (FLAP/SPD)**

Displays selected approach reference flap and speed setting.

Manual input of desired flap and/or speed settings may be made.

Valid entry format is FF/SSS, SSS, /SSS, FF/ or F/, where F or FF is a flap setting of 0, 1, 2, 5, 10, 15, 25, 30, 40 and SSS is a speed within the range allowed in 1R to 3R.

Entries may be deleted and are blanked at flight completion.

7 **Wind Correction (WIND CORR)**

Displays current wind correction for approach. Default is +05 knots.

Manual input of desired wind correction may be made up to +20 knots.

8 Glideslope (G/S)

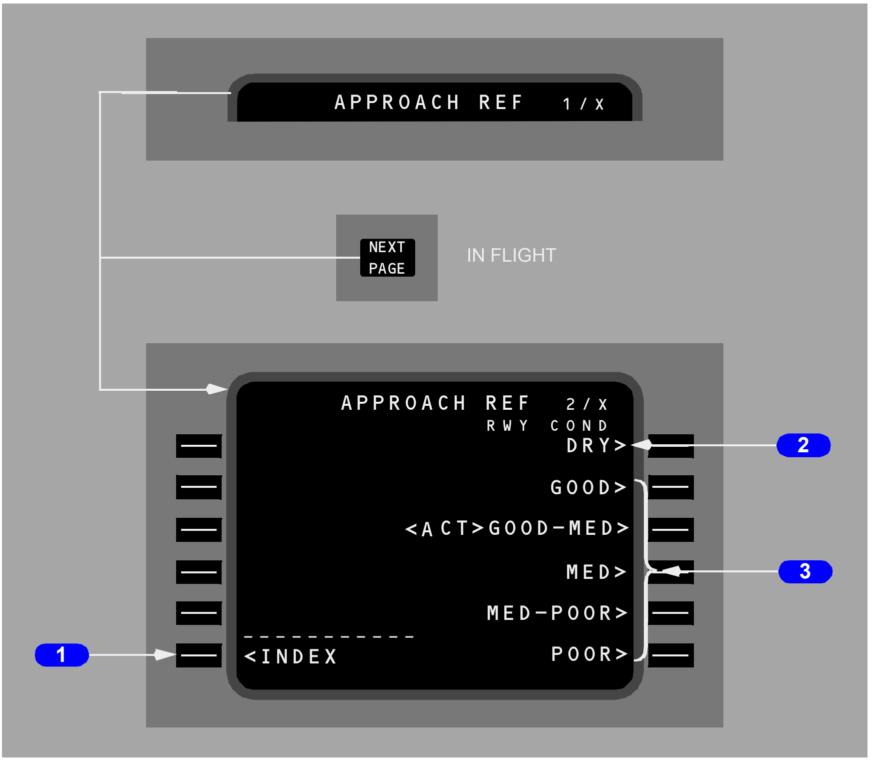
Toggles glideslope ON and OFF for the selected or active approach.

When an ILS or IGS approach is selected in the FMC, G/S defaults to ON.

When a LOC, SDF, LDA or BCS approach is selected in the FMC, G/S defaults to OFF.

Approach Reference Page (2/2)

Approach reference page 2/X enables selection of the landing runway condition.



1 INDEX

Push – selects the INIT/REF INDEX page.

2 DRY

"DRY>" is displayed when the runway overrun alert is enabled. Pressing LSK 1R sets the runway condition to DRY

"DRY", with no caret ">", is displayed when the runway overrun alert is inhibited. Pressing LSK 1R when the overrun alert is inhibited, will not change the runway condition.

A runway condition of DRY will be set upon power up and whenever a change to the active destination airport is executed.

Note: A runway condition of DRY will be set due to a change in the destination airport when the overrun alert is inhibited.

"<ACT>" is displayed next to the active runway condition when the runway alert system is not inhibited.

3 Additional Runway Conditions

A ">" is displayed to the right of the runway condition when the runway overrun alert is not inhibited. Pressing the LSK key sets the runway condition to the appropriate runway condition.

No ">" is displayed when the runway overrun alert is inhibited. Pressing the LSK key will not change the runway condition.

"<ACT>" is displayed next to the active runway condition when the runway alert system is not inhibited.

The FMC outputs a numeric maximum airplane braking coefficient value corresponding to the runway condition selection according to the table below:

Runway Condition Input	Maximum Airplane Braking Coefficient
DRY	0.30
GOOD	0.20
GOOD-MED	0.15
MED	0.10
MED-POOR	0.08
POOR	0.05

Holding

The FMC computes holding patterns with constant radius turns based on current winds and FMC commanded airspeed. The pattern size is limited to FAA or ICAO protected airspace. In LNAV, the AFDS tracks the holding pattern using up to a 30 degree bank angle. Strong winds or airspeed in excess of FAA or ICAO entry speeds may result in the airplane flying outside the protected airspace.

The FMC generates steering commands to enter, track, and exit a holding pattern inserted into the active flight plan through CDU action by the pilot.

With LNAV active before sequencing the holding fix, holding pattern entries are determined by the following:

- the angle between the flight plan leg into the holding fix and the holding inbound course determines the entry method used (parallel, teardrop or direct entry)
- the airplane flies the initial outbound leg for a specified time (1.0 minute at or below 14,000 feet and 1.5 minutes above 14,000 feet)

- teardrop entries use an FMC calculated offset angle designed to intercept the outbound leg at the point where the inbound turn begins
- parallel and teardrop entries may cause the airplane to fly beyond the displayed holding pattern; however, the airplane remains in protected FAA or ICAO limits.

Descent in Holding

The FMC provides the capability for starting descents when in the holding pattern airspace with a T/D displayed on one of the holding legs. This is based on the airplane entering the Hold in the Cruise phase of flight.

- The requirement is to descend in VNAV while holding when a T/D is encountered in the holding pattern, the MCP ALT has been lowered, and the EXIT ARMED mode has been executed.

When an exit from a holding pattern is requested by the pilot through a CDU action:

- a turn path to the inbound leg is generated immediately if the airplane is on the outbound leg or in the fix end turn when the T/D does not occur in the hold pattern.
- the entire hold pattern is flown when the T/D occurs in the hold pattern.

After EXIT HOLD has been executed, T/D, if applicable, will be displayed on the holding exit lateral path. The FMC switchs from cruise to descent upon passing T/D if the MCP altitude is lower than the FMC CRZ altitude. The descent is performed in a SPEED on Elevator mode at holding speed until leaving the HOLD.

HOLD Page

The hold page is used to enter a holding pattern into the route.

When the flight plan does not have a holding pattern, push the HOLD function key to show the LEGS page with the HOLD AT line.

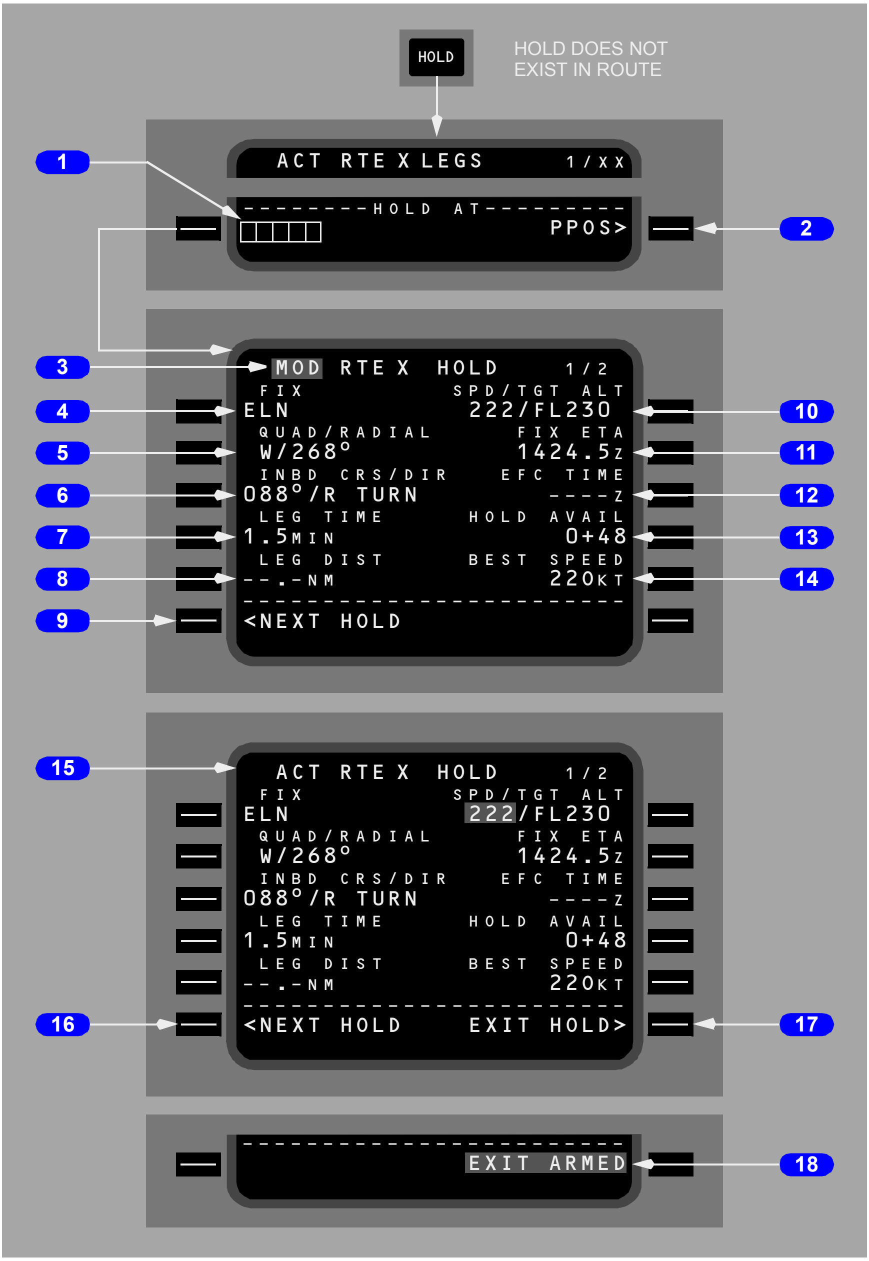
Two versions of the hold page are possible:

- an airway or procedure holding pattern (from the navigation database)
- a flight crew–entered holding pattern.

The holding page shows actual or default data about the holding pattern.

Entries make route modifications, which can be erased or executed.

Active holding patterns are magenta on the navigation display.


HOLD
HOLD DOES NOT EXIST IN ROUTE
ACT RTE X LEGS 1/XX
--------HOLD AT---------
PPOS>
MOD RTE X HOLD 1/2
FIX
ELN
SPD/TGT ALT
222/FL230
QUAD/RADIAL
W/268°
FIX ETA
1424.5Z
INBD CRS/DIR
088°/R TURN
EFC TIME
----Z
LEG TIME
1.5MIN
HOLD AVAIL
0+48
LEG DIST
--.-NM
BEST SPEED
220KT
<NEXT HOLD
ACT RTE X HOLD 1/2
EXIT HOLD>
EXIT ARMED
1
2
3
4
5
6
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18

1 HOLD AT

When the HOLD function key is pushed and no holding pattern exists in the route, the LEGS page shows prompts to enter the holding fix. Enter the holding fix to show the RTE HOLD page.

Displays a prompt to enter the holding fix, a route waypoint, or present position.

A waypoint is entered as the holding fix.

2 HOLD AT Present Position (PPOS)

Selects the airplane present position as the holding fix.

Only displayed during flight when not in a holding pattern.

3 Modified Route Hold Status

MOD indicates that the holding fix has not been executed.

Execution changes the page title to RTE HOLD (ACT RTE HOLD if holding at PPOS).

4 FIX

Displays waypoint identifier of the holding fix.

Entry is propagated either automatically from the database, or from a manual entry on the HOLD AT page.

If PPOS was selected on the HOLD AT page, then the FMC assigns PPOS as the fix identifier.

5 Quadrant/Radial (QUAD/RADIAL)

Displays holding pattern quadrant and radial.

Entry is propagated either automatically from the database, or from a manual entry on the HOLD AT page.

The default holding pattern inbound course and turn direction are in small font. Crew entered or holding patterns extracted from the database are in large font.

Valid entry is XXX (radial) or XX/XXX (quadrant/radial). Valid quadrant entry is N, NE, E, SE, S, SW, W, NW.

Quadrant shall be determined by the resulting inbound course.

6 Inbound Course/Direction (INBD CRS/DIR)

Displays holding inbound course and turn direction.

Entry is propagated either automatically from the database, or from a manual entry on the HOLD AT page.

The default holding pattern inbound course and turn direction are in small font. Crew entered or holding patterns extracted from the database are in large font.

Valid entry is XXX (inbound course), XXX/X (inbound course/turn direction), /X or X (turn direction).

Automatically changes QUAD/RADIAL to agree.

For a flight crew–entered holding pattern, the inbound course is initially the same as the preceding leg to the fix.

For a flight crew–entered holding pattern, if no entry is made, the FMC assumes right turns.

Magenta when the holding fix is the active waypoint.

7 LEG TIME

Displays holding pattern leg time.

Valid entry is XXX.X. Manual entry has priority.

If no entry is made, the FMC assumes the standard times of 1.0 minute at or below 14,000 feet and 1.5 minutes above 14,000 feet.

The default leg times are displayed in small font. Crew entered or holding patterns extracted from the database are displayed in large font.

The holding pattern will automatically be resized when climbing or descending through 14,000 feet if the holding pattern size is not defined in the database or has not been manually entered.

If a LEG DIST is manually entered, then dashes will be displayed.

8 Leg Distance (LEG DIST)

Dash prompts are normally displayed.

Entry may be propagated either automatically from the database, or made by manual entry.

Manual entry has priority.

Overrides

LEG TIME.

9 NEXT HOLD

Displayed when the route contains less than five holding patterns.

Push – displays (RTE LEGS) HOLD AT page and prompts for new holding fix entry.

To delete the hold modification return to the RTE or RTE LEGS page and select ERASE prompt at LSK 6L.

10 Speed/Target Altitude (SPD/TGT ALT)

Displays current speed and altitude (small font).

Speed or altitude constraint may be entered. Manual entries are in large font and propagate to LEGS page.

Note: When a cruise hold exists, cruise speed changes propagate around the hold but have no effect on holding speed.

11 Fix Estimated Time of Arrival (FIX ETA)

Displays computed time for next passage over holding fix.

12 Expect Further Clearance Time (EFC TIME)

Entry of the EFC time will help optimize FMC performance computations.

Computation of destination fuel assumes that departure from the holding fix will occur at this time.

13 Hold Available (HOLD AVAIL)

Displays available holding time in hours + minutes remaining if destination is to be reached with planned fuel reserves as entered on PERF INIT page.

14 BEST SPEED

Displays computed best holding speed based on present altitude and conditions.

Note: May exceed maximum speed permitted by regulatory agency.

15 Active Route Hold Status

ACT indicates that the airplane has entered the holding pattern.

16 NEXT HOLD

Displayed when the route contains less than five holding patterns and there is no route modification in progress.

Push – displays (RTE LEGS) HOLD AT page and prompts for new holding fix entry.

17 EXIT HOLD

Displayed on the holding page when in the holding pattern.

Used when preparing to depart holding pattern.

Push – changes prompt to EXIT ARMED and illuminates execute key.

18 EXIT ARMED

Displayed on the holding page when in the holding pattern and after line selection of EXIT HOLD prompt.

Execution activates LNAV flight back to the holding fix via a shortened holding pattern, departure from holding pattern, and continued flight along the active route. ACT RTE LEGS page 1/XX appears after holding exited.

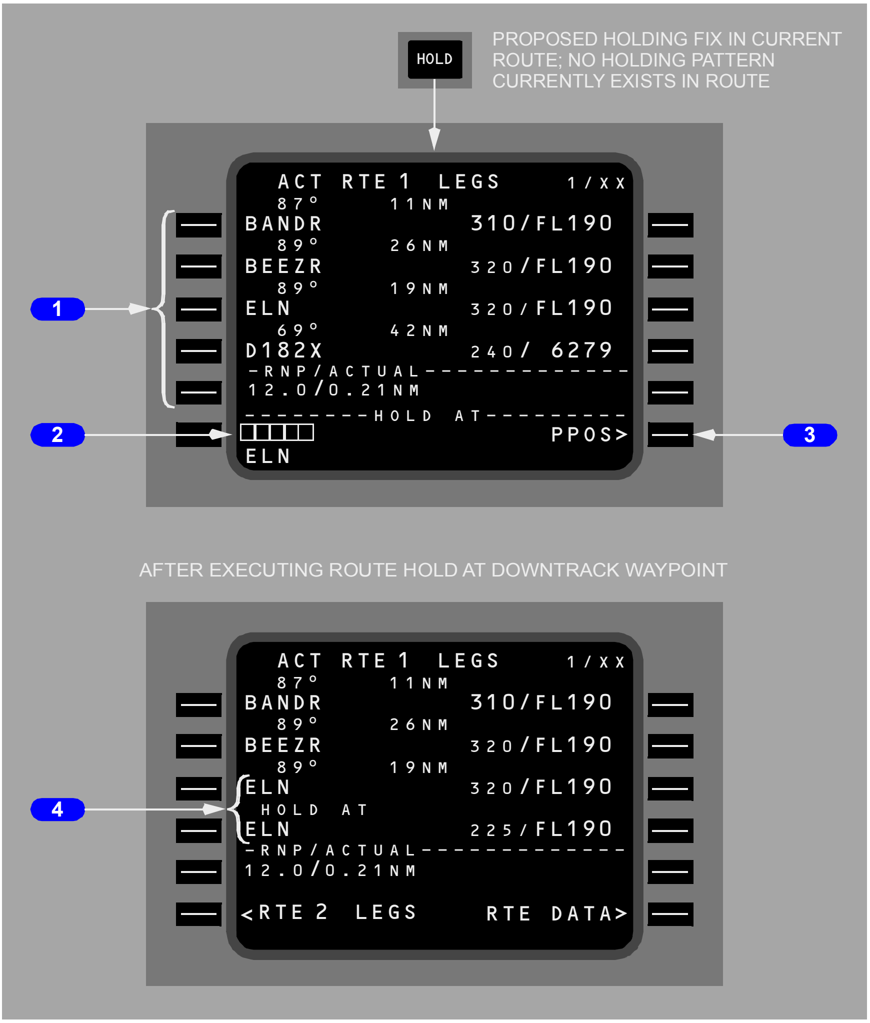
Highlighted in reverse video after execution.

RTE LEGS HOLD AT (Fix in Route)

Used to enter proposed fix for racetrack holding pattern at either present position or any waypoint.

A maximum of five holding patterns may exist at one time.

Two holding patterns may exist at the same waypoint if one is in the route and the other is in the missed approach.



1 Data Lines

Display same data as the corresponding RTE LEGS page.

2 HOLD AT

Used to enter any waypoint identifier, which then defines a holding fix.

Entry may be via keyboard, or by transfer of any downpath waypoint which is in the existing route (the example depicts ELN line selected into the scratch pad).

Following line selection of the desired waypoint into the box prompts, the MOD RTE HOLD page appears and the execute key illuminates.

3 Present Position (PPOS)

Push – selects holding fix at present position. The MOD RTE HOLD page appears and the execute key illuminates ("present" is at the time of execution of the MOD RTE HOLD page).

Displayed only in flight.

Default parameters are a standard holding pattern on the inbound leg.

4 Hold at Waypoints (HOLD AT)

A holding fix creates a new HOLD AT waypoint following the leg to that waypoint.

Displayed on the RTE LEGS page in the proper route sequence after executing the related MOD RTE HOLD page.

RTE LEGS HOLD AT (Fix not in Route)

1 Hold at Waypoint (HOLD AT XXXX)

Displayed in the scratch pad whenever the entry in the HOLD AT line is not a waypoint in the existing route (the example above depicts entry of PLUSS).

Route position of the holding fix is defined by line selecting to the desired LEGS page sequence.

Following line selection to the desired LEGS page sequence, the MOD RTE HOLD page appears and the execute key illuminates.

2 Hold at Waypoints (HOLD AT)

A holding fix creates a new HOLD AT waypoint following the leg to that waypoint.

Displayed on the RTE LEGS page in the proper route sequence after executing the related MOD RTE HOLD page.

3 ROUTE DISCONTINUITY

The entered route must always form a continuous path of linked legs.

The example depicts a HOLD AT entry where the entry was not a downpath waypoint.

The FMC computes a direct course to the off–route holding fix.

The HOLD AT waypoint becomes a termination identifier which is not part of the existing route. The resulting route discontinuity is identified by box prompts, requiring entries to define the route after PLUSS.

Intentionally
Blank

Flight Management, Navigation — Chapter 11
FMC Messages — Section 60

Introduction

FMC messages tell the flight crew when system operation is degraded or if there are data input errors.

FMC messages show in the CDU scratchpad. The messages are categorized as:

- alerting messages
- entry error messages
- advisory messages.
- FMC data link messages (alerting and advisory)
- ATC data link messages (alerting)
- FMC Navlink ACARS messages (active, inactive, and scratch pad)

The FMC messages are shown according to their level of importance. Alerting messages are most important, followed by entry error messages. Advisory messages are least important. If multiple messages exist, a less important message replaces another message in the scratchpad when the CLR key is pushed or the condition is corrected.

The amber FMC alert light on each pilot's main panel illuminates when there is an FMC alerting message. All FMC messages illuminate the CDU message (MSG) light. Clear the message or correct the condition to cancel the message.

The following tables are general lists; some messages may not apply to all FMC configurations.

FMC Alerting Messages

These messages relate to operationally significant conditions which affect FMC operation.

FMC alerting messages:

- are shown in the CDU scratchpad
- cause the amber FMC alert light on each pilot's main panel to illuminate
- illuminate message lights (MSG) on both CDUs.

Use the CLR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
CRZ ALT CHANGED TO XXXXX	An altitude constraint added due to entering a new company route, a new destination airport, or selection of a new procedure conflicts with the cruise altitude, resulting in automatically raising the cruise altitude to match the highest waypoint altitude constraint in the mod plan, when not in active descent.	Clear the message. Verify MCP cruise altitude.
CHECK ALT TGT	VNAV disengages while airplane is between MCP and FMC altitudes or VNAV button pressed while airplane is between MCP and FMC altitudes.	Clear the message.
CUTBACK DISARMED	Cutback turned off as a result of changing or deleting the flight plan runway while on the ground.	Clear the message. Re-arm as required.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
CUTBACK UNAVAILABLE	The FMC is unable to compute a Cutback N1 value.	Clear the message.
CYCLE IRS OFF–NAV	IRS is unable to complete alignment under current conditions.	Cycle IRS mode selector to “OFF” and back to “NAV.”
DATA BASE INVALID	The automatic validity test of the permanent navigation database has failed.	Advise maintenance personnel to check the FMC and reload the database, as required. If desired, consider the use of the temporary nav database.
DISCO INSRTD AFTR XXXXX (waypoint identifier)	A ROUTE DISCONTINUITY has been inserted into the flight plan due to undefined termination of a downpath leg or a triple waypoint BYPASS.	Select the RTE or RTE LEGS pages and modify the waypoints for a continuous route.
DISCONTINUITY	Passing the last waypoint in the route prior to a ROUTE DISCONTINUITY (LNAV disengages) or pressing LNAV while in a discontinuity.	Select the RTE LEGS page. Enter the desired active waypoint into the box prompts. Correct any ROUTE DISCONTINUITY and EXECute. Reengage LNAV.
DRAG REQ AFTER XXXXX	A waypoint speed constraint greater than 10 knots above the predicted speed exists at waypoint XXXXX.	Modify flight plan as required. Clear the message.
END OF OFFSET	Two minutes prior to passing offset leg termination.	Confirm clearance.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
END OF ROUTE	LNAV engaged and passing the last waypoint in the route (LNAV disengages).	Select the RTE LEGS page. Enter the desired active waypoint into the dash prompts and EXECute. Reengage LNAV.
ENG OUT SID MOD	An engine–out SID has been automatically inserted into the flight plan as a modification.	Clear the message.
ENTER IRS POSITION	IRS in the alignment mode needs present position to complete alignment. Previous present position entry was not received back from the IRS.	Enter IRS present position into the scratchpad pad and line select 4R on the POS INIT page of the CDU. If present position was previously entered, overwrite displayed data. If necessary, enter present position directly into the IRS control /display unit.
FMC APP/TUNE DISAGREE (U13.0)	An approach that utilizes FMC generated glide path is in the active flight plan but an approach navaid (ILS/GLS) has been tuned with G/S ON.	Confirm the tuned frequency and approach selected in the FMC are both consistent with the actual approach intended to be flown. Resolve tuning or approach selection inconsistency. Clear the message.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
FMC APP/TUNE DISAGREE (U14.0 and above)	An approach that utilizes FMC generated glide path is in the active flight plan but an approach navaid (ILS/GLS/LPV) has been tuned with G/S ON.	Confirm the tuned frequency and approach selected in the FMC are both consistent with the actual approach intended to be flown. Resolve tuning or approach selection inconsistency. Clear the message.
FMC DISAGREE	During approach or on the ground, monitored parameters required for dual FMC operation are in disagreement. (Dual FMC as installed) Message will remain displayed until the condition has been resolved. The FMC does not check for mach and indicated airspeed miscompares on the ground.	Monitor FMCs closely. Both FMCs remain online. Limit approaches to single FMC only. If desired, revert to SINGLE FMC OPERATION in this section.
FMC DISAGREE - VERTICAL	A vertical deviation, FMC Airspeed, or FMC Mach value disagreement between the FMCs by more than the allowed tolerance occurs and long enough that all attempts to resynchronize failed while the aircraft in a path descent. Message display is inhibited when in the Approach Nav environment. (dual FMC as installed)	Do not move the FMC source select switch. Monitor crossing altitudes to ensure compliance.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
FMC POS/RW DISAGREE	Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
FUEL DISAGREE	The totalizer fuel quantity and the FMC calculated fuel quantity disagree. Illuminates the FMC P/RST Light. Message displayed on Engine display.	Refer to FUEL DISAGREE non-normal checklist in the QRH. The Engine Display message will remain until the condition is no longer valid.
GPS-L INVALID GPS-R INVALID	FMC is no longer receiving valid information from the displayed GPS system.	Clear the message. For ADS-B operations (if installed), when one GPS is invalid, ensure that the transponder selector is positioned to the side with the valid GPS. For dual GPS installations, if both GPS-L INVALID and GPS-R INVALID messages show, refer to FMC Navigation Check supplementary procedure. For single GPS installations, refer to FMC Navigation Check supplementary procedure

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
INSUFFICIENT FUEL	FMC fuel at the destination is predicted to be less than 2000 lbs/900 kilograms. Scratchpad message shows for Active and Mod Flight Plan. Illuminates the FMC P/RST Light for Active and Mod Flight Plan. Message displayed on Engine display for the Active Flight Plan only.	Refer to INSUFFICIENT FUEL non-normal checklist in the QRH. The Engine Display message will remain until the condition is no longer valid.
IRS MOTION	IRS has automatically restarted the alignment due to detection of excessive motion.	Clear message and attempt to reduce airplane movement, if practicable.
IRS-(L or R) DRIFT	An FMC has detected that the IRS-(L or R) position or velocity data is unreasonable, and deselected IRS-(L or R) due to velocity divergence or position blunder checks.	Refer to FMC Navigation Check Supplementary Procedure.
IRS POS/ORIGIN DISAGREE	Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
LNAV BANK ANGLE LIMITED	LNAV is engaged and the airplane is not on a lateral offset and is not near or in an orbit or hold and the airplane is within 5 minutes or less from an LNAV guided course change, and will exceed the airway/route boundaries for non-flyover turns less than or equal to 135 degrees due to performance limited bank angle. This message does not apply to fixed radius turns.	Review the LNAV course change. If course change exceeds airway/route boundary, consider flight plan change.
MAX ALT FLXXX (flight level value)	Altitude intervention (as installed) attempt to raise cruise altitude when MCP altitude is above maximum altitude.	Clear the message.
MISSED CAPTURE U14 Removes [MISSED CAPTURE]	Proper localizer capture maneuver was performed, but the AFDS did not capture.	Clear the message
MODEL/ENG DATA INVALID	A valid performance database is not available.	Contact maintenance personnel.
NAV DATA OUT OF DATE	Effectivity dates of nav database do not agree with date input from clock.	Check the IDENT page and reverse the dates for ACTIVE NAV DATA if required.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
NAV INVALID–TUNE XXXXX (navaid identifier)	FMC is unable to auto–tune or receive the navaid for a RNAV or VOR approach procedure.	Cross–check radios and manually tune the desired navaid.
NO VNAV AFTER XXXXX,	The descent path is monitored independent of path construction for the following scenarios: A) - an “at”, “at or above”, “at or below” or “window” constraint is violated B) - a navigation data base gradient (vertical angle) is violated If a violation is detected and not resolved, VNAV will disconnect after the point of the violation. The alerting message is displayed one minute prior to the violation.	After sequencing waypoint XXXXX, VNAV INVALID - PERF logic applies: Pilot should reenter the CI using either the previous CI displayed or enter a new CI. Reengage VNAV when change has been EXECuted.
OAT DISAGREE - DELETED	A check of entered OAT versus sensed OAT occurs after first engine start. A difference of +/- 6 degrees Celsius between the OAT value on the N1 LIMIT / TAKEOFF REF page and the engine temperature sensors.	Enter updated/corrected OAT on the N1 LIMITS page.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
OVERSPEED DISCONNECT	During path descent and above or below the speed restriction altitude, VNAV disengages when airspeed exceeds FMC speed restriction by more than 15 knots.	Manually reduce speed and reengage VNAV.
PARTIAL ROUTE X LOADED	A route is loaded into the active/inactive RTE 1 or 2 flight plan buffer which references data not contained in any of the databases.	Clear the message.
PERF DEFAULTS INVALID	Validity check of performance defaults database has failed.	Contact maintenance personnel.
RESET MCP ALT	During the FMC cruise phase with VNAV engaged, when within 5 NM of the top-of-descent point without selecting a lower altitude on the AFDS MCP.	Select lower MCP altitude values as clearances permit.
RTA UNACHIEVEABLE	The RTA is not in the computed RTA window under current parameters.	Enter an achievable RTA or discontinue the RTA mode of navigation. Adjust parameters to meet the RTA.
RW/APP TUNE DISAGREE	During approach, manual tuned approach frequency or channel does not match active flight plan.	Clear the message and select correct approach frequency.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
RW/APP CRS ERROR	During approach, MCP selected course does not match front course for the approach in the active flight plan.	Clear the message and select correct MCP course.
SCANNING DME FAIL	Inputs from both frequency scanning DME radios have failed.	Clear the message and check position. Radio updating of FMC position is not available.
SELECT MODE AFTER RTA	RTA mode has been discontinued due to sequencing of RTA waypoint or RTA waypoint has been removed from the flight plan.	Select alternate performance mode. (ECON, manual speed, etc.)
SINGLE FMC OPERATION	The primary FMC has determined that the secondary FMC is not available. (Dual FMC as installed)	If the FMC source selector switch is in the “Normal” position, move to “BOTH ON L”. No action is required if the FMC source selector switch is already positioned to “BOTH ON L” or “BOTH ON R”.
SW OPTIONS INVALID	The CRC performed during power up BIT on the current software options data base has failed, or the CRC of the software options data base that has been loaded via the data loader has failed.	Reload the FMC OPC software by maintenance.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
TAKEOFF SPEEDS DELETED	A change to runway, runway data, takeoff thrust selection or performance data is made after the V speeds have been selected, or entered V speeds fail to meet relative value check. A check, after first engine start, of entered OAT versus sensed OAT has a difference of +/- 6 degrees Celsius.	Reselect new V speeds and clear message. Enter updated/corrected OAT on the N1 LIMITS page, then reselect new V speeds and clear message.
THRUST REQUIRED	Airplane is in an underspeed condition.	Clear the message. Increase airspeed to within 15 knots of speed target.
UNABLE HOLD AIRSPACE	The lateral predicted hold path using the bank angle limit causes protected airspace to be exceeded.	Review the holding pattern. If holding pattern exceeds allowable holding airspace, consider flight plan change.
UNABLE NEXT ALTITUDE	Unable to meet the next flight plan altitude constraint in a VNAV climb or descent. The message appears only with VNAV engaged.	Clear the message and review the prediction. For undershoot condition during climb, consider selection of MAX RATE CLB or MAX ANGLE CLB, or a different N1 limit as appropriate.
UNABLE PROC AIRSPACE	Minimum procedure turn built by guidance exceeds the allowable excursion distance.	Modify flight plan as required. Clear the message.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
UNABLE YYY KTS AT XXXXX	Next waypoint speed restriction (speed YYY, at waypoint XXXXX) cannot be met.	Modify flight plan as required. Clear the message.
UNABLE REQD NAV PERF–RNP (U13 and later)	FMC actual navigation performance is not sufficient for the displayed RNP. UNABLE REQD NAV PERF-RNP message will be displayed if there is a divergence between IRU-L and IRU-R inertial altitude, or between IRS-L and IRS-R inertial vertical speed, when the aircraft is on an RNP-AR approach leg.	Refer to UNABLE REQD NAV PERF-RNP non-normal checklist in the QRH. Note: When on a procedure or airway without an RNP alerting requirement, the FMC Navigation Check supplementary procedure in SP11 can be used to verify position. If a UNABLE REQD NAV PERF-RNP is shown during the RNP-AR approach, whether the lateral or vertical RNP are exceeded or not, do the Go-Around and Missed Approach Procedure unless suitable visual reference is established and maintained.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
USING RSV FUEL	FMC fuel at the destination is predicted to be less than the entered RESERVES fuel. Scratchpad message shows for Active and Mod Flight Plan. Illuminates the FMC P/RST Light for Active and Mod Flight Plan. Message displayed on Engine display for the Active Flight Plan only.	Refer to USING RSV FUEL non-normal checklist in the QRH. The Engine Display message will remain until the condition is no longer valid.
VERIFY GW AND FUEL	Fuel data becomes invalid, PERF INIT fuel value is replaced with dashes. FMC uses last valid fuel quantity for performance predictions until manual entry is made. Shows if 30 minutes have elapsed since last manual entry. Does not show in descent with Vref selected.	Enter fuel weight on PERF INIT page 1/2. Periodic update of fuel weight is required to keep gross weight value current.
VERIFY POS: FMC-FMC	Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POS: FMC-GPS	Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
VERIFY POS: FMC-RADIO	Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POS: IRS-FMC	Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POS: IRS-IRS	Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POS: IRS-RADIO	Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POSITION (on ground)	Position information is contradictory.	Clear message. Check accuracy of manually entered data. Crosscheck IRS, GPS and FMC positions. Manually re-align both IRS's if needed.
VERIFY RNP	Underlying RNP value is less than manually entered value.	Enter appropriate RNP.
VERIFY TAKEOFF SPEEDS	A PERF INIT change has been made after takeoff speeds were specified.	On TAKEOFF REF page 1, accept previous V speeds, or reject previous V speeds and enter new V speeds.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
VERIFY TAKEOFF THRUST	With the Takeoff Thrust Auto Selection option enabled, the system determines that the selected takeoff thrust setting is not compatible with the engine thrust rating configuration.	Clear the message. Manually change takeoff thrust setting, or accept uplink of different thrust setting.
VERIFY VERT RNP	During an active descent with navigation performance scales enabled, a manually entered vertical RNP is greater than the default vertical RNP.	Clear CDU message. Enter appropriate vertical RNP.
VNAV DISCONNECT	The criteria for VNAV engagement is not satisfied (VNAV disengages). On approach, with VNAV engaged, the FCC has switched to LVL CHG.	Manually control the vertical path.
VNAV INVALID-PERF	If the exception affects both the MOD and the ACT flight plan, the Cost Index (CI) will be replaced with box prompts on the PERF INIT page and the message will result. LNAV is still valid and can navigate the airplane laterally but VNAV will disconnect. Reference section 11.32 for further Software Exception Logic.	Pilot should reenter the CI using either the previous CI displayed or enter a new CI. Reengage VNAV when change has been EXECuted.

FMC Entry Error Messages

These messages relate to incorrect scratchpad entries. FMC entry error messages:

- are shown in the CDU scratchpad
- illuminate the message light (MSG) of the CDU where the entry error was made
- temporarily overwrite data in the scratchpad.

Use the CLR key or key in new data to remove the message. If the CLR key is used to remove the message, the data previously entered is once again displayed. If new data is keyed in over the message, the message and the data previously entered are removed.

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
ALT CONSTRAINT XXXXX (waypoint identifier)	A flight plan modification has caused an altitude conflict with a waypoint that has an altitude constraint.	Clear the message and revise the entry.
DATA BASE FULL	Entry attempted into a supplemental or temporary navigation database category which is full.	Go to the NAV DATA pages and delete unneeded waypoints, navaids, or airports from the appropriate database and re–attempt entry.
DUPLICATE FLIGHT PLAN ID	The entry attempted is a duplicate of an existing supplemental flight plan name.	Clear the message and select a unique flight plan name.
INVALID DELETE	DEL key operation was attempted for a data line to which it was not applicable.	Clear the message and select the proper line after the DEL key is pressed.
INVALID ENTRY	Attempted data entry has incorrect format, range, etc. for the selected data line. Entered RTA waypoint is not in the flight plan.	Clear the message and scratchpad entry, and repeat the entry with the correct data.

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
INVALID QUAD	Attempted HOLD page QUAD entry has incorrect format or range.	Clear the message and revise the QUAD entry.
NO OFFSET AT LEG XXXXX (waypoint)	Attempted entry of a lateral offset start or end waypoint XXXXXX that is not offsetable (lateral offset as installed).	Clear the message and amend the route.
NOT IN DATA BASE	FMC does not contain the required data for the entered identifier.	Clear the message and check data entry, or enter the required information into the supplemental or temporary navigation database via the NAV DATA pages.
NOT IN FLIGHT PLAN	RTA waypoint or lateral offset (as installed) start/end waypoint entry is not in the active flight plan.	Clear the message and amend the entry.
ROUTE FULL	Entry of more than maximum allowed number of waypoints or holding patterns attempted.	Clear the message and review existing and desired waypoints and holding patterns for possible deletion.
SUPP RTE DATA BASE FULL	Attempted save of the 11th supplemental flight plan.	Clear the message, delete unneeded supplemental flight plans and re–attempt entry.

FMC Advisory Messages

These messages relate to FMC status. FMC advisory messages:

- are shown in the CDU scratchpad
- illuminate message lights (MSG) on both CDUs.

Use the CLR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
ABOVE MAX CERT ALT	The airplane is above its maximum certified altitude.	Descend to an altitude below the maximum certified altitude.
APPRCH VREF NOT SELECTED	Airplane has transitioned into approach environment and Vref has not been selected on APPROACH REF page.	Select Vref on APPROACH REF page.
ARR N/A FOR RUNWAY	Runway or approach does not match the selected arrival procedure.	Go to the ARRIVALS page and modify selection.
BUFFET ALERT (Only appears if flaps are retracted)	Current conditions result in a maneuver margin less than specified.	Bring the airplane back within the operating envelope.
CHECK FMC FUEL QUANTITY	The FMC has detected an unexpected drop in the fuel quantity.	Check the fuel quantity indications for correctness.
DRAG REQUIRED	Airspeed is 10 kts or more above FMC target speed or within 5 kts of Vmo/Vmmo.	Use speedbrakes, trim or reduced thrust, as required, to bring the airplane within 5 kts of FMC target speed.
ENTER EO CRZ SPD AND ALT	Engine-out operation has been terminated and no cruise speed or altitude has been entered.	Enter cruise speed and altitude on cruise page.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
FMC APP MODE UNAVAIL–GP	The approach selected in the FMC does not have a specified glide path angle for final approach. The FMC approach mode cannot be used for this approach.	Select an alternate approach. Clear the message.
FMC APP MODE UNAVAIL–QFE	An approach that utilizes FMC generated glide path is in the flight plan, but QFE is selected on the FMC.	Select QNH as the landing altimeter reference on the APPROACH REF page. Clear the message.
INVALID INACTIVE PLAN	An exception has occurred in the INACTIVE plan prior to execution and it has been deleted as a result.	Reenter a new version of the INACTIVE plan.
INVALID MOD PLAN	An exception has occurred in the MOD plan and it has been deleted as a result.	Reenter a new version of the MOD plan.
INVALID OFFSET	Desired offset does not meet FMC offset criteria.	Clear the message and amend the entry.
KEY/FUNCTION INOP	A mode key is pressed for which an FMC function has not been implemented or has not been enabled. (FANS MCDU only)	Clear the message or select another CDU page for display.
LOC CAP ACTIVE U14 Removes [LOC CAP ACTIVE]	The airplane is approaching its turn onto the localizer or GLS course and will maintain an intercept heading.	Clear the message manually, or wait for the AFDS to signal reset status to the FMC.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
LOC CAP ACTIVE	The airplane is approaching its turn onto the LOC or GLS course and will maintain an intercept heading.	Clear the message manually, or wait for the AFDS to signal reset status to the FMC.
LOC CAP CANCELLED U14 Removes [LOC CAP CANCELLED]	Flight plan modifications or the airplane condition did not facilitate localizer capture.	Clear the message manually, or wait for the AFDS to reset to LOC CAP ACTIVE
MAX ALT FLXXX (flight level value)	Altitude entry on any page is above the maximum altitude for current selected performance margins.	Clear the message or amend the data entry.
MAX MACH .XXX/MIN MACH .XXX OR MAX CAS .XXX/MIN CAS .XXX	FMC target speed is greater than the maximum or less than the minimum buffet speed for the entered cruise or step climb altitude.	Change the target speed to within the message limits or enter a lower altitude.
NO DES PATH AFTER XXXXX (waypoint)	FMC is unable to construct a PATH DES that satisfies all altitude restrictions after XXXXX.	Modify speed or altitude restrictions on the RTE LEGS pages.
NOT ON INTERCEPT HEADING	Airplane is not within the LNAV capture criteria for the active leg (LNAV disengages). If the LNAV button is pressed and the airplane is not within the capture criteria. (LNAV will not engage)	Manually place the airplane on an intercept heading and reengage LNAV.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
OFFSET DELETED	The entered start waypoint has been deleted from the flight plan. (lateral offset as installed)	Clear the message and amend the route.
OFST ENDS ABEAM XXXXXX	An invalid offset leg exists between the end waypoint (XXXXXX) and the start of offset or no end waypoint exists.	Clear the message and amend the route.
PERF DEFAULTS DELETED	Performance database has been automatically deleted due to conflict with performance database limits.	Contact maintenance personnel.
POS SHIFT OVER 50NM	A viable position shift is currently selected that will result in an FMC position shift in excess of 50nm when executed.	Clear the message.
PROGRAM PIN ERROR	FMC connector wiring is incorrect.	System unusable; advise maintenance personnel. The CLR key will not clear the message.
PROGRAM PIN NOT IN DB	FMC connector wiring or performance database is incorrect.	Advise Maintenance Personnel
RESET MCP ALT	Normal FMC operation would require flying away from MCP altitude.	Select a MCP altitude value in the proper direction (higher for climb, lower for descent).
RESET MCP APP MODE	A change in the expected approach is made with an FCC approach mode armed or engaged.	Clear and rearm FCC approach mode. Clear the message.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
RUNWAY N/A FOR SID	The selected runway is not applicable to the selected departure procedure.	Clear the message and check selections on the DEPARTURES page. Modify as required.
SELECT ACTIVE WPT/LEG	Power–up restart or insertion of a different flight plan while airborne.	EXECute a direct–to or leg intercept to tell the FMC which leg of the route is active.
STEEP DESCENT AFTER XXXXXX	An excessive vertical discontinuity exists after point XXXXXX.	Check routing.
TAI ON ABOVE 10°C	Airplane is operating with anti–icing with TAT above +10°C.	Clear the message and check the use of anti–icing for engines and/or wings.
UNABLE CRZ ALT	FMC predicts that no cruise time is possible at the entered CRZ ALT.	Clear the message and review the CRZ ALT selection.
UNABLE MACH. XXX	The entered cruise Mach is unattainable based on present gross weight.	Select a smaller Mach number or wait until gross weight is reduced sufficiently.
UNABLE TO OFFSET	A valid offset cannot be constructed due to geometric limitations.	Clear the message and amend the route.
V SPEEDS UNAVAILABLE	FMC cannot compute V speeds (as installed) due to unreasonable inputs on the RTE, PERF INIT, or TAKEOFF REF pages.	Correct inputs that affect V speed computation.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
VERIFY RNP VALUE	When entering an RNP the underlying RNP value is smaller than the manually entered value or the ANP is greater than the manually entered RNP.	Change or delete the manually entered RNP.
VERIFY VERT RNP VALUE	With navigation performance scales enabled, a manually entered vertical RNP is greater than the default vertical RNP or manually entered vertical RNP is less that vertical ANP.	Clear the message. Change or delete the manually entered RNP.
XXXX (airport identifier)	A REF AIRPORT is entered on the POS INIT page and no entry of ORIGIN yet appears on RTE page 1.	Enter the airport identifier on the ORIGIN data line.
XXXXX (MCP altitude value)	With the CRZ page displayed, resetting the AFDS MCP altitude to a value different from the CRZ ALT causes the value to appear in the scratchpad.	Enter the MCP altitude value on the appropriate target altitude data line.

FMC Data Link Messages

These messages relate to FMC data link message status. FMC data link alerting and advisory messages function the same as the alerting and advisory messages described above:

FMC Data Link Alerting Messages

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
ALTN DEST UPLINK	An FMC alternate destinations uplink message has been loaded on the ALTERNATE DESTS page, and is ready for flight crew review. (Alternate destinations as installed)	Review the alternate destinations uplink.
CRZ WIND UPLINK LOADING	An FMC cruise wind uplink message is loading (after LOAD selected on the RTE DATA page).	Wait for load to complete.
CRZ WIND UPLINK READY	Receipt of an ACARS uplink that contains cruise wind data, and the cruise wind data LOAD prompt is displayed on the RTE 1 or 2 DATA page.	Select RTE DATA page, LOAD cruise wind, and execute or ERASE.
CRZ WIND XXXXX (cruise altitude) UPLINK	An FMC cruise wind uplink message has been loaded on the RTE DATA page, and is ready for flight crew review.	Review the cruise wind uplink, and execute or ERASE.
DATALINK CONFIG INVALID	Validity check of the FMC datalink configuration file has failed.	Contact maintenance personnel.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
DESCENT FORECASTS UPLINK	An FMC descent forecasts uplink message has been loaded on the DESCENT FORECASTS page, and is ready for flight crew review.	Review the descent forecasts uplink, and execute or ERASE.
FORECASTS UPLINK READY	An FMC descent forecasts uplink message has been received and is available for loading on the DESCENT FORECASTS page.	Select DESCENT FORECASTS page, LOAD descent forecasts winds, and execute or ERASE.
INVALID TAKEOFF XXX/YYY (runway or runway/intersection identifier)	Runway (RTE page) or runway/intersection (TAKEOFF REF page) has been entered that matches runway takeoff data in FMC memory. However, the airplane is performance limited for the selected runway.	Clear the message. Enter correct takeoff data, request new takeoff data uplink, or enter new runway or runway/intersection identifier.
NAV DATA LOADING	An FMC supplemental navigation data uplink message has been received and is loading.	Wait for load to complete.
NAV DATA UPLINK	An FMC supplemental navigation data uplink message has been loaded on the SUPP NAV DATA page, and is ready for flight crew review.	Review the supplemental navigation data uplink, and execute or ERASE.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
PARTIAL ALTN DEST UPLINK	An FMC alternate destinations uplink message has been loaded on the ALTERNATE DESTS page, but errors were encountered during the loading process. (Alternate destinations as installed)	Review the alternate destinations uplink, and execute or ERASE.
PARTIAL FORECASTS UPLINK	An FMC descent forecasts uplink message has been loaded on the DESCENT FORECASTS page, but errors were encountered during the loading process.	Review the descent forecasts uplink, and execute or ERASE.
PARTIAL LIMITS UPLINK	An FMC performance limits uplink message has been loaded on the PERF LIMITS page, but errors were encountered during the loading process.	Review the performance limits uplink, and execute or ERASE.
PARTIAL NAV DATA UPLINK	An FMC supplemental navigation data uplink message has been loaded on the SUPP NAV DATA page, but errors were encountered during the loading process.	Review the supplemental navigation data uplink, and execute or ERASE.
PARTIAL PERF INIT UPLINK	An FMC performance initialization uplink message has been loaded on the PERF INIT page, but errors were encountered during the loading process.	Review the performance initialization uplink, and execute or ERASE.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
PARTIAL ROUTE X UPLINK	Receipt of an ACARS non-ATC uplink message that contains route data. The route data has been partially loaded into the active/inactive RTE 1 or 2 flight plan buffer due to errors.	Review the route uplink, and execute or ERASE.
PERF INIT UPLINK	An FMC performance initialization uplink message has been loaded on the PERF INIT page, and is ready for flight crew review.	Review the performance initialization uplink, and execute or ERASE.
PERF INIT UPLINK READY	An FMC performance initialization uplink message has been received and is available for loading on the PERF INIT page.	Select PERF INIT page, LOAD performance initialization data, and execute or ERASE.
PERF LIMITS UPLINK	An FMC performance limits uplink message has been loaded on the PERF LIMITS page, and is ready for flight crew review.	Review the performance limits uplink, and execute or ERASE.
PERF LIMITS UPLINK READY	An FMC performance limits uplink message has been received and is available for loading on the PERF LIMITS page.	Select PERF LIMITS page, LOAD performance limits, and execute or ERASE.
RESEND MESSAGE	An FMC downlink message was attempted, but the FMC was unable to deliver the message to the ACARS MU.	Re–send the downlink message.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
ROUTE X DATA UPLINK	An FMC route uplink message has been loaded into the active/inactive RTE 1 or 2 flight plan buffer, and is ready for flight crew review.	Review the route uplink, and execute or ERASE.
ROUTE X UPLINK LOADING	Receipt of an ACARS non-ATC uplink message that contains route data. The route data is currently being loaded into the active or inactive RTE 1 or 2 flight plan.	Wait for load to complete.
ROUTE X UPLINK READY	Receipt of an ACARS non-ATC uplink that contains route data, and the route data LOAD prompts are displayed on the active/inactive RTE 1 or 2 and active/inactive LEGS 1 or 2 pages.	Select the active/inactive RTE 1 or 2 page or active/inactive LEGS 1 or 2 page, LOAD route, and execute or ERASE.
RTA DATA UPLINK	An FMC RTA uplink message has been loaded on the RTA PROGRESS page, and is ready for flight crew review.	Review the RTA uplink, and execute or ERASE.
RTA UPLINK READY	An FMC RTA uplink message is has been received and is available for loading on the RTA PROGRESS page.	Select RTA PROGRESS page, LOAD RTA data, and execute or ERASE.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
TAKEOFF DATA LOADED	Uplink takeoff data matching Runway (RTE page) or runway/intersection (TAKEOFF REF page) has been loaded on the TAKEOFF REF page, and is ready for flight crew review.	Select TAKEOFF REF page, accept or reject takeoff data.
TAKEOFF DATA UPLINK	An FMC takeoff data uplink message containing one or more sets of runway takeoff data has been received and loaded in FMC memory.	Enter appropriate runway (RTE page) or runway/intersection (TAKEOFF REF page) to access runway takeoff data.

FMC Data Link Advisory Messages

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
INVALID ALTN DEST UPLINK	An FMC alternate destinations uplink message was received, but was rejected due to errors.	Clear the message.
INVALID CRZ WIND UPLINK	An FMC cruise wind uplink message was received, but was rejected due to errors.	Clear the message.
INVALID FORECASTS UPLINK	An FMC descent forecasts uplink message was received, but was rejected due to errors.	Clear the message.
INVALID LIMITS UPLINK	An FMC performance limits uplink message was received, but was rejected due to errors.	Clear the message.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
INVALID NAV DATA UPLINK	An FMC supplemental navigation data uplink message was received, but was rejected due to errors.	Clear the message.
INVALID PERF INIT UPLINK	An FMC performance initialization uplink message was received, but was rejected due to errors.	Clear the message.
INVALID ROUTE or ROUTE X UPLINK	An FMC route uplink message was received, but was rejected due to errors.	Clear the message.
INVALID RTA UPLINK	An FMC RTA uplink message was received, but was rejected due to errors.	Clear the message.
INVALID TAKEOFF UPLINK	An FMC takeoff data uplink message was received, but was rejected due to errors.	Clear the message.

ATC Data Link Messages

These messages relate to ATC data link message status. ATC data link alerting and advisory messages function the same as the alerting and advisory messages described above:

ATC Data Link Alerting Messages

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
ATC DATABASE INVALID (U14.0 and above)	ATC data base is not available/loaded at power up on the ground.	Clear CDU Message
ATC COMM ESTABLISHED	Active ATC connection established.	Clear message.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
ATC COMM TERMINATED	ATC connection terminated without transfer to another service station.	Clear message.
ATC MESSAGE	Receipt of valid ATC datalink message.	Clear message and display the received ATC uplink.
ATC REPORT LIST FULL	ATC REPORT buffer is full.	Clear message and send or delete reports listed on the ATC REPORT page.
ATC ROUTE X DATA UPLINK	Receipt of am ATC ACARS uplink message containing route data. The route data has been loaded into the active RTE 1 or 2 flight plan buffer.	Review the route uplink, and execute or ERASE.
ATC ROUTE X UPLINK LOADING	Receipt of an ATC ACARS uplink message containing route data. The route data is currently being loaded into the active RTE 1 or 2 FMC flight plan buffer.	Clear message.
ATC ROUTE X UPLINK READY	Receipt of an ATC ACARS uplink that contains route data, and the route data LOAD prompts are displayed on the active/inactive RTE 1 or 2 and active/inactive LEGS 1 or 2 pages.	Select the active/inactive RTE 1 or 2 page or active/inactive LEGS 1 or 2 page, LOAD route, and execute or ERASE.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
ATC RTA DATA UPLINK	Receipt of an ATC ACARS uplink message containing RTA data. The RTA data is currently being loaded into the active RTE 1 or 2 flight plan.	Review the RTA uplink, and execute or ERASE.
CLEARANCE CONDITION MET (U14.0 and above)	The clearance being monitored is met.	Perform clearance instruction
CLEARANCE COND NOT MET (U14.0 and above)	The clearance being monitored is executed prior satisfying clearance.	Review clearance being monitored, select "MONITOR" on ATC INDEX page. Comply with ATC clearance
CLR COND NOT IN RTE (U14.0 and above)	When the waypoint in the clearance being monitored is deleted from the active route or a clearance is accepted and the waypoint is not in the active route..	Review clearance being monitored, select "MONITOR" on ATC INDEX page. Comply with ATC clearance
ATN DATA BASE INVALID (U14.0 and above)	ATN Data Base is not available/loaded and FANS-2 option is enabled	Load ATN Data Base
ATC TIMEOUT-RESEND (U14.0 and above)	CPDLC downlink has been sent and the required response has not been received	Resend message

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
DATALINK LOST	Datalink connectivity has been lost	Notify ATC of the loss of FANS datalink connectivity.
INVALID ATC (ROUTE or ROUTE X) UPLINK	ATC uplink received by FMC contains errors.	Clear message.
INVALID ATC UPLINK	ATC uplink received by FMC contains errors.	Clear message.
MESSAGE LIMIT EXCEEDED	Crew attempts to select more than five message elements for inclusion in downlink message.	Clear message.
PARTIAL ATC ROUTE X UPLINK	Receipt of an ATC ACARS uplink message containing route data which passed syntax error checks, but contained errors in the data, and part of the active RTE 1 or 2 flight plan data has been loaded.	Review the route uplink, and execute or ERASE.
PARTIAL CLEARANCE LOADED	FMC able to load only a portion of data.	Clear message and reject uplinked clearance.
RE–LOGON TO ATC COMM	No response to logon message after 10 minutes.	Clear message and re-send logon message.
RESPOND TO ATC UPLINKS	ATC uplink pending storage full.	Clear message and respond to open uplinks.
UNABLE TO LOAD CLEARANCE	FMC unable to load any data from uplink.	Clear message and reject uplinked clearance.
UNABLE TO SEND MSG	Manual initiation of downlink failed.	Clear message.

Navlink ACARS Messages

Navlink ACARS Advisory Messages

Advisories are shown on the CDU next to L6 and R6. They signal the crew that either a condition requires attention or that a function is available. Typically a crew action extinguishes the advisory.

ACTIVE ADVISORY	CAUSE	CORRECTIVE ACTION
CONFIG	Airline ID or the Registration Number is not available to the CMU-900.	Advise maintenance.
BAD ACTYPE	Improper aircraft type loaded.	Advise maintenance.
APM ICAO	Aircraft Personality Mode (APM) status is INDETERMINATE because of an (ICAO) address conflict between the APM and the transponder broadcast.	Advise maintenance.
SELCAL	Voice go–ahead uplink message received.	Selected SELCAL page or select voice mode.
APM WARN	APM status is FAIL or ABSENT.	Advise maintenance.
CHIMES	A chimes suppression event has occurred. When selected, this advisory causes the CHIMES SUPPRESSED page to show.	This advisory clears when it is selected. The CHIMES advisory is then disabled until the CMU-900 has been restarted (a power cycle has occurred).

INACTIVE ADVISORY	CAUSE	MESSAGE CLEARED
LINK TEST SUCCESSFUL	Successful data link test of the communication medium (VHF, SATCOM, or HF) has been completed.	Message clears after ten seconds.
UTC UPDATED	A UTC Clock Update message has been received from the ground.	Message clears after ten seconds.
VHF VOICE MODE	The CMU-900 system is in VHF Voice Mode.	Shows for the duration that the system remains in VHF Voice Mode, and is cleared when the system returns to Data Mode.
NO COMM	Neither VHF, SATCOM, nor HF media have established a link with the ground over which a message may be sent.	Advisory shows for the duration that the system remains without a link, and is cleared when the system establishes a link.
VHF IN PROG	The system has sent a downlink message via VHF and has not yet received an acknowledgment from the service provider.	Advisory clears when all VHF messages have been acknowledged, or the VHF link fails and VHF goes to NO COMM.
SATCOM IN PROG	The system has sent a downlink message via SATCOM and has not yet received an acknowledgment from the service provider.	Advisory clears when all SATCOM messages have been acknowledged or the SATCOM link fails.

INACTIVE ADVISORY	CAUSE	MESSAGE CLEARED
HF IN PROG	The system has sent a downlink message via HF and has not yet received an acknowledgment from the service provider.	Advisory clears when all HF messages have been acknowledged or the HF link fails.

Scratch Pad Messages

CDU SCRATCH PAD	CAUSE	CORRECTIVE ACTION
FORMAT ERROR	Shows when a line select key associated with manual entry is selected and the scratch pad data does not pass format or range checking.	Reformat manual entry.
BUTTON PUSH IGNORED	Shows when a line select key that has no assigned function on the display page is selected.	Select correct line select key.
NOT ALLOWED	Shows when a line select key associated with manual entry is selected but the scratch pad is empty.	Enter appropriate data in scratch pad if applicable.

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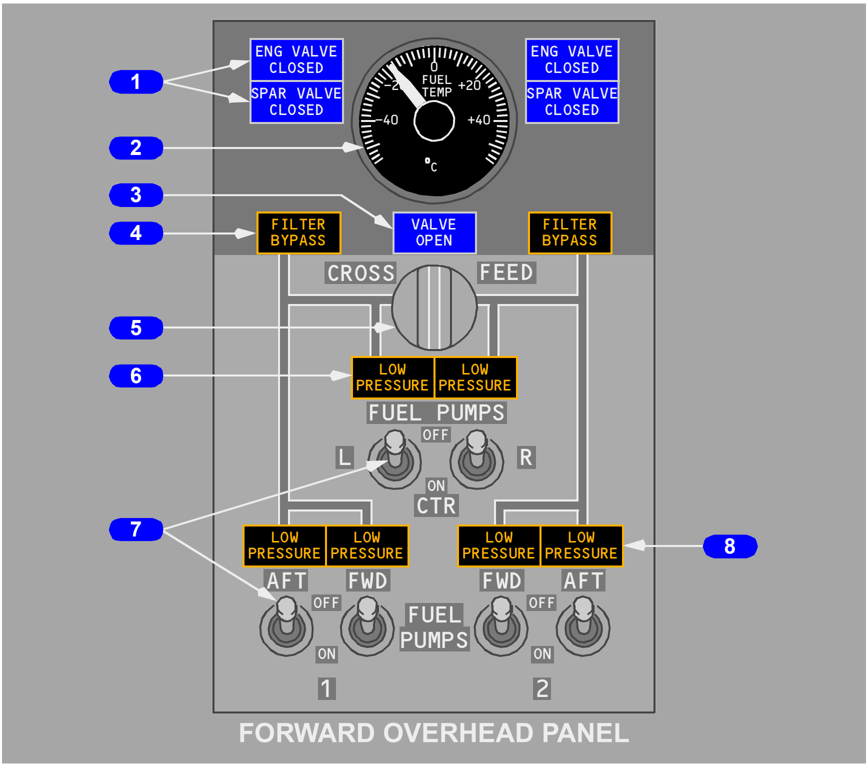
Fuel Control Panel



1 Engine Valve Closed (ENG VALVE CLOSED) and SPAR VALVE CLOSED Lights

Extinguished – related engine or spar fuel shutoff valve is open.

Illuminated (blue) –

- bright – related engine or spar fuel shutoff valve is in transit, or valve position and engine start lever or engine fire switch disagree.
- dim – related engine or spar fuel shutoff valve is closed.

2 FUEL Temperature (TEMP) Indicator

Indicates fuel temperature in No. 1 tank.

3 Crossfeed VALVE OPEN Light

Extinguished – crossfeed valve is closed.

Illuminated (blue) –

- bright – crossfeed valve is in transit, or valve position and CROSSFEED selector disagree.
- dim – crossfeed valve is open.

4 FILTER BYPASS Lights

Extinguished – fuel filter operating normally.

Illuminated (amber) – impending or actual fuel filter bypass due to a contaminated filter. If both lights are illuminated, both lights will remain illuminated until engine shutdown on the ground.

5 CROSSFEED Selector

Controls fuel crossfeed valve.

Closed – isolates engine No. 1 and No. 2 fuel feed lines.

Open – connects engine No. 1 and No. 2 fuel feed lines.

6 Center Tank FUEL PUMP LOW PRESSURE Lights

Illuminated (amber) – fuel pump output pressure is low and FUEL PUMP switch is ON.

Note: With the Center (CTR) tank FUEL PUMP switches ON, continuous illumination of one LOW PRESSURE light for 10 seconds illuminates MASTER CAUTION and FUEL system annunciator lights.

Extinguished – fuel pump output pressure is normal, or FUEL PUMP switch is OFF.

7 FUEL PUMP Switches

ON – activates fuel pump.

OFF – deactivates fuel pump.

Note: When a center tank fuel pump switch is set to OFF, the auto shutoff logic for that pump is reset. When the center tank fuel pump switch is set to ON after being OFF, the pump will again activate until the switch is set to OFF or auto shutoff logic deactivates it.

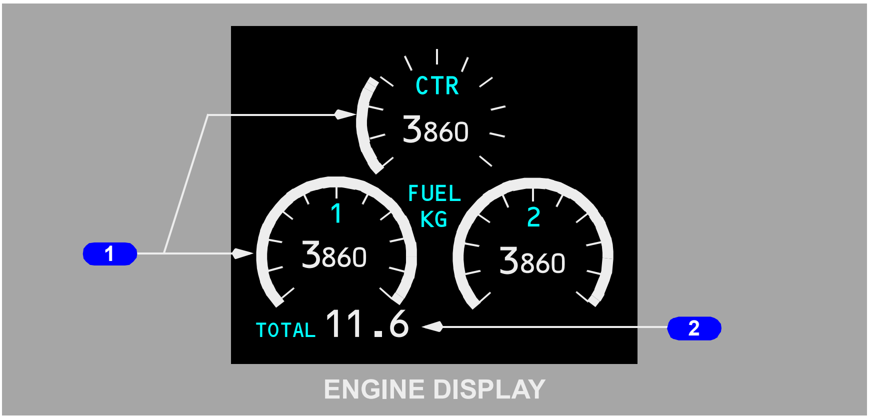
8 Main Tank FUEL PUMP LOW PRESSURE Lights

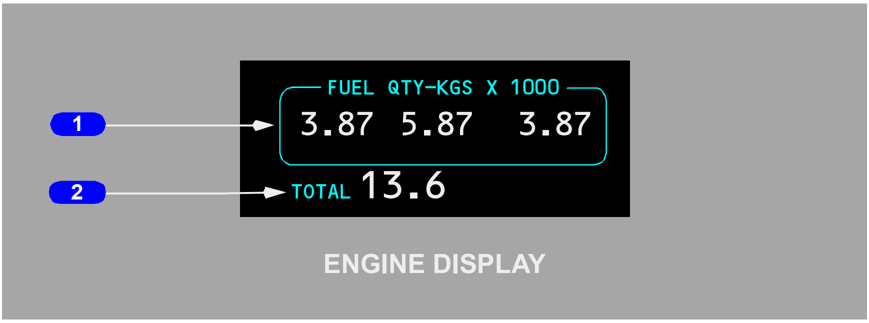
Illuminated (amber) – fuel pump output pressure is low, or FUEL PUMP switch is OFF.

Note: Two LOW PRESSURE lights illuminated in same tank illuminate MASTER CAUTION and FUEL system annunciator lights. One LOW PRESSURE light causes MASTER CAUTION and FUEL system annunciator lights to illuminate on MASTER CAUTION light recall.

Extinguished – fuel pump output pressure is normal.

Fuel Quantity Indications





1 FUEL Quantity Indicators

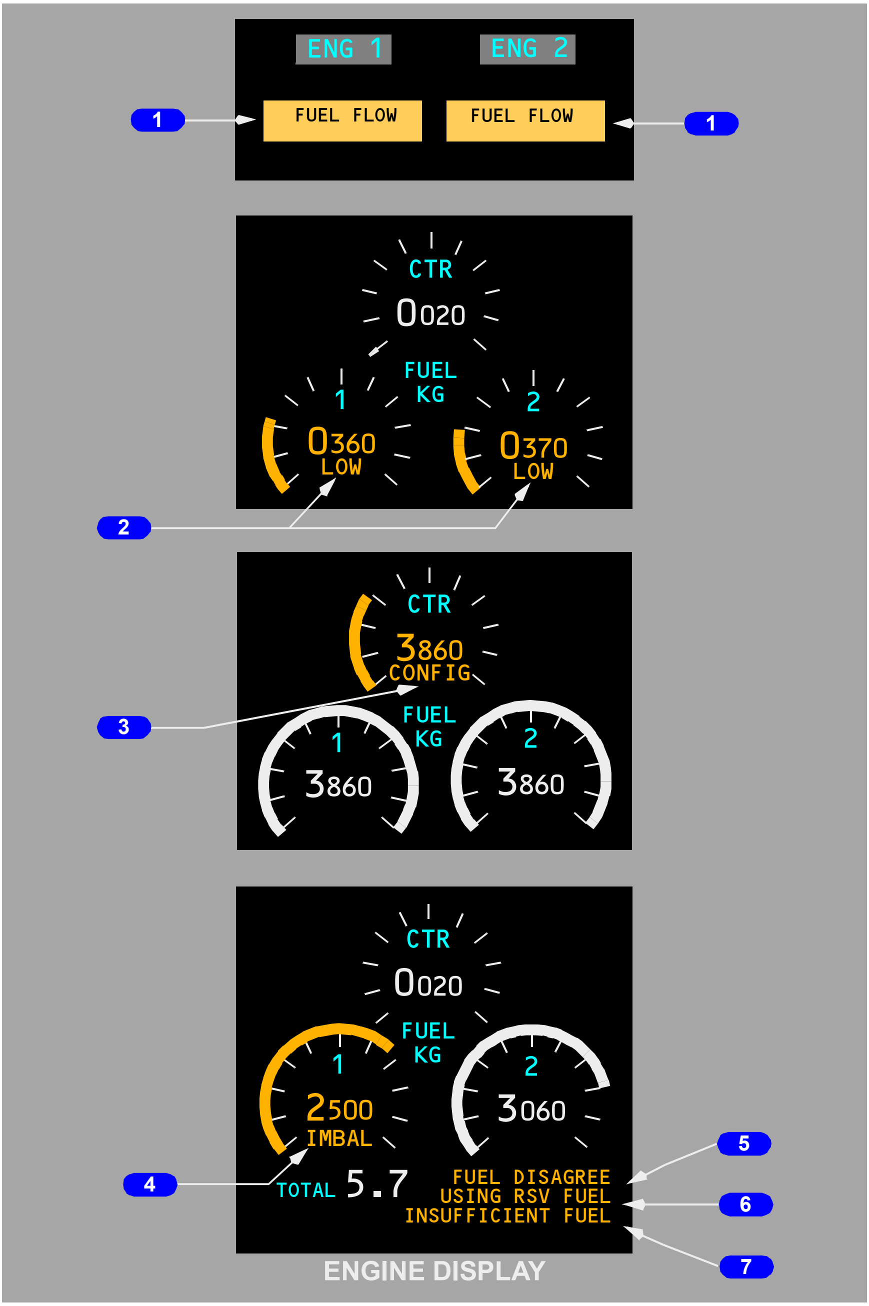
Displayed (white) – indicates usable fuel in related tank:

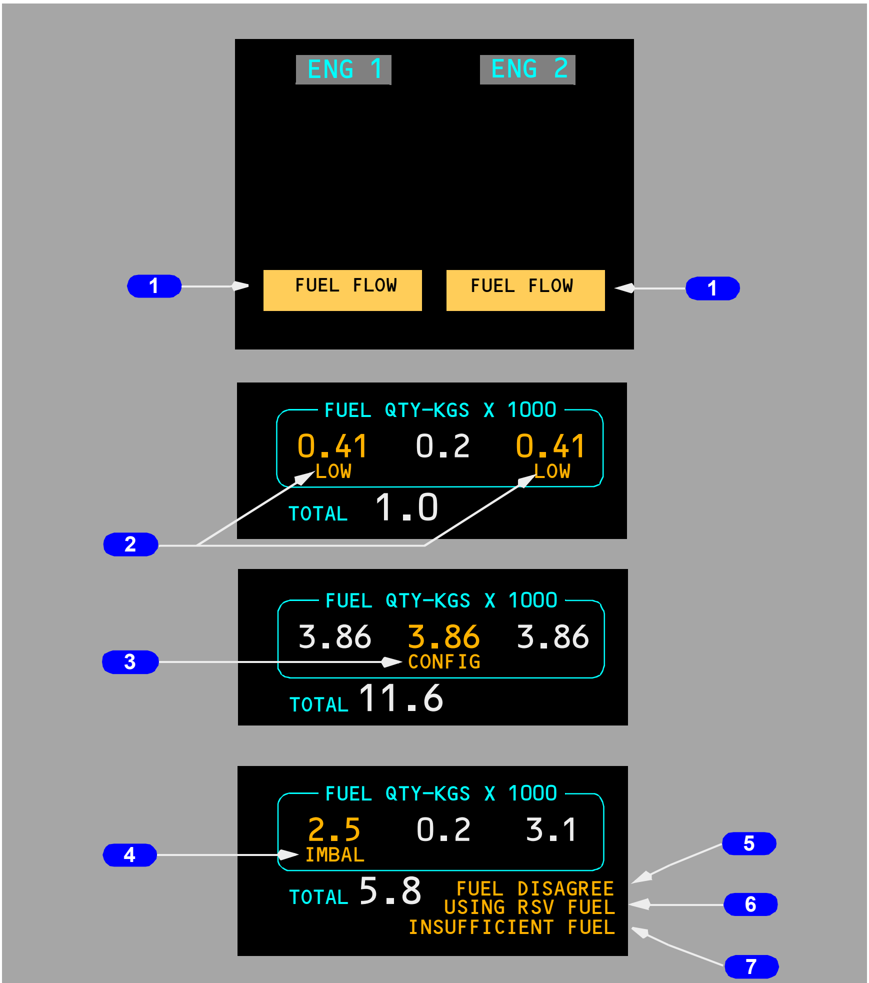
- available with AC or DC power.

2 Total Fuel Quantity Indicator

Displayed (white) - indicates total useable fuel.

Fuel Alert Indications





ENGINE DISPLAY

1 Fuel Flow (FUEL FLOW) Alert

Illuminated (amber) - the difference between actual engine fuel flow rate and the FMCS expected fuel flow rate exceeds the MEDB threshold value for five continuous minutes. The message is displayed independently for each engine.

2 Fuel LOW Alert

Displayed (amber) –

- fuel tank quantity less than 907 kgs in related main tank
- display remains until fuel tank quantity is increased to 1134 kgs

The fuel quantity arc and digits on tank(s) with low fuel quantity turn amber or

The fuel quantity digits on tank(s) with low fuel quantity turn amber.

3 Fuel Configuration (CONFIG) Alert

Displayed (amber) –

- either engine running
- center fuel tank quantity greater than 726 kgs; and
- both center fuel tank pump switches positioned OFF

The quantity arc and digits on the center tank fuel quantity indicator turn amber or

The quantity digits on the center tank fuel quantity indicator turn amber.

Display remains until –

- both engines not running
- center fuel tank quantity less than 363 kgs
- one center fuel tank pump switch ON

The quantity arc and digits on the center tank fuel quantity indicator return to normal or

The quantity digits on the center tank fuel quantity indicator return to normal.

4 Fuel Imbalance (IMBAL) Alert

Displayed (amber) –

- main tanks differ by more than 453 kgs
- displayed below main tank with lower fuel quantity
- displayed when airplane is on the ground or in the air
- inhibited by fuel LOW indication when both indications exist
- displayed until imbalance is reduced to 91 kgs

The fuel quantity arc and digits on tank with lower fuel quantity turn amber or

The fuel quantity digits on tank with lower fuel quantity turn amber.

5 Fuel Disagree (FUEL DISAGREE) Alert

Displayed (amber) - The totalizer fuel quantity and the FMC calculated fuel quantity disagree.

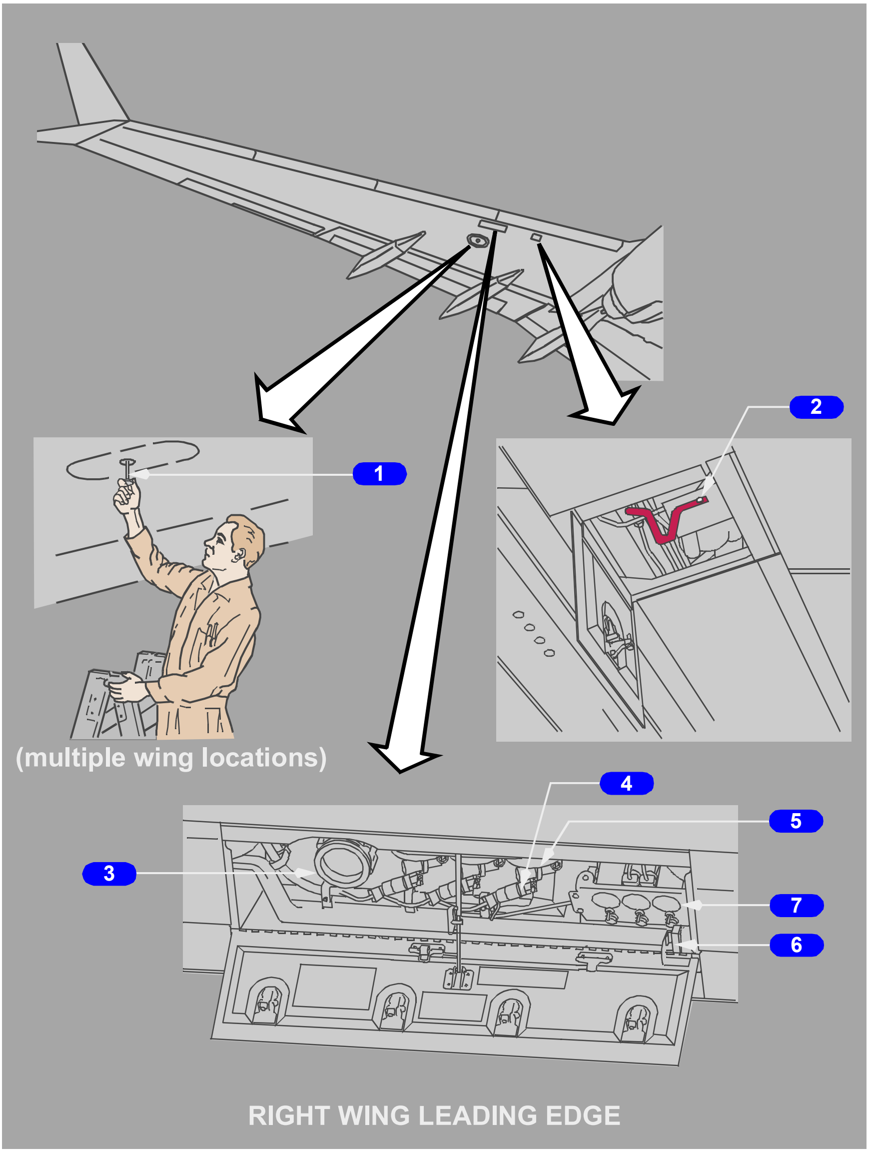
6 Using Reserve Fuel (USING RSV FUEL) Alert

Displayed (amber) - FMC fuel at the destination is predicted to be less than the entered RESERVES fuel.

7 Insufficient Fuel (INSUFFICIENT FUEL) Alert

Displayed (amber) - FMC fuel at the destination is predicted to be less than 900 kilograms.

Fueling / Defueling / Measurement



1 Fuel Measuring Stick

Allows comparison of fuel quantity or weight as determined from measuring stick reading and fuel weight indicated by fuel quantity indicators:

- six fuel measuring sticks are installed in each main tank and four are installed in center tank
- reading is obtained by withdrawing measuring stick from tank and latching it magnetically to an internal float. Fuel depth is read where stick passes through wing skin.

2 Manual Defueling Valve

Open – interconnects engine feed system and fueling station for:

- defueling
- ground transfer of fuel.

Closed – isolates engine feed system from fueling station.

3 Fueling Receptacle

Hose connection receptacle for single point fueling.

4 Solenoid Override

Mechanically opens solenoid operated valve. Fuel valve opens if fuel pressure is available.

5 Fueling Valves

With the battery switch ON, and the refueling door open, fuel pressure opens valve.

6 Refueling Power Control Relay

Door closed – proximity sensor deactivates power to fueling system.

Door open – the fueling system is powered and panel lights illuminate.

7 Test Gauges & Fueling Panel

Test Gauges and Fueling Panel

8 FUELING INDICATION TEST SWITCH

(spring–loaded to OFF position)

TEST GAUGES – checks operation of fuel quantity indicators.

FUEL DOOR SWITCH BYPASS – energizes fueling panel if refueling power control relay fails.

9 Fueling VALVE POSITION LIGHTS

Extinguished –

- fueling valve switch is OPEN and related tank is full
- fueling valve switch is CLOSED.

Illuminated (blue) – fueling valve switch is OPEN and related tank is not full.

10 Fueling Valve Switches

OPEN – energizes fueling valve in related tank.

CLOSED – de–energizes fueling valve in related tank.

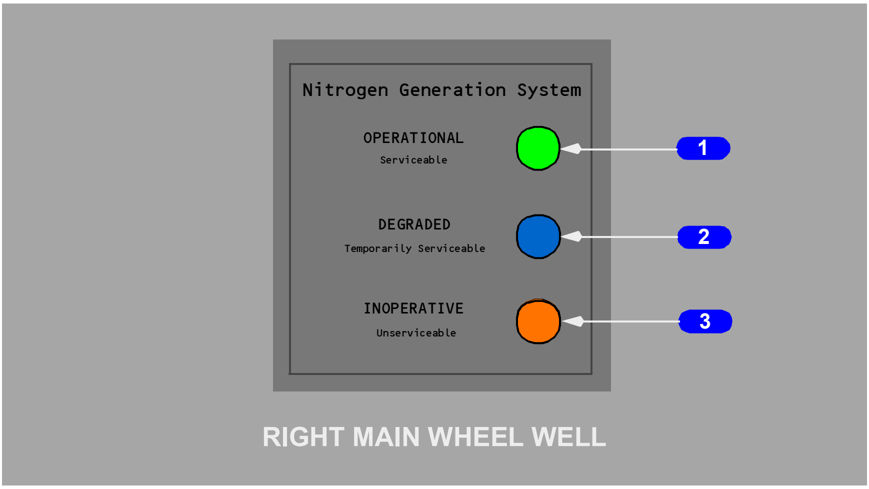
11 FUEL Quantity (QTY) Indicators

Indicates total usable fuel tank quantity in related tank.

12 Fuel Quantity Selectors

Rotate – sets total fuel quantity desired in related tank.

Nitrogen Generation System (NGS)



1 OPERATIONAL Light (green)

NGS is fully operational.

2 DEGRADED Light (blue)

NGS is operational, but is operating in a degraded condition.

3 INOPERATIVE Light (amber)

NGS is inoperative.

Note: No lights illuminated also indicates NGS is inoperative.

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Fuel — Chapter 12
System Description — Section 20

Introduction

The fuel system supplies fuel to the engines and the APU. Fuel is contained in three tanks located within the wings and wing center section.

Refer to Chapter 7, Engines, APU, for a description of the engine and APU fuel systems.

Fuel Feed

Both engines are normally pressure fed from the center tank until the center tank quantity decreases to near zero. The engines are normally then pressure fed from their respective main tanks. Check valves are located throughout the fuel system to ensure the proper direction of fuel flow and to prevent transfer of fuel between tanks.

Nitrogen Generation System (NGS)

The NGS converts bleed air to nitrogen-enriched air (NEA) during all phases of flight. The NEA is delivered to the center fuel tank to reduce flammability of the tank. The operation of the NGS is transparent to the flight crew; it does not require any flight crew action to operate the system, nor are there any flight deck indications. The NGS automatically starts operating after take-off and runs continuously through climb, cruise, descent, landing and during taxi for a short period of time. The NGS shuts down after a specified period of time or when bleed pressure is no longer available. The NGS also automatically shuts down during the following non-normal flight conditions:

- Aircraft on the ground and not in test mode
- Either engine is not running in flight
- Fire or smoke detection in the cargo or main deck areas
- Left air conditioning pack overheat
- Center tank refueling valve is open

The fuel tanks are primarily protected by precluding ignition sources; hence dispatch with the NGS inoperative is acceptable under MEL procedures.

The NGS has an operability indicator located in the main wheel well adjacent to the APU fire control panel.

Fuel Pumps

Each fuel tank uses two AC powered fuel pumps which are cooled and lubricated by fuel passing through the pump. Center tank pumps produce higher pressure than main tank pumps. This ensures that center tank fuel is used before main tank fuel, even though all fuel pumps are operating. Individual pressure sensors monitor the output pressure of each pump.

Each center tank pump will automatically shut off, after a short delay, when that pump’s sensor detects low output pressure.

Note: Fuel pump LOW PRESSURE lights may flicker when tank quantity is low and the airplane is in a climb, descent, or on the ground with a nose-down attitude.

Note: Center tank fuel pump LOW PRESSURE lights may flicker when tank quantity is low and the airplane is in cruise. One pump may indicate low pressure sooner than the other due to aircraft attitude and/or slight variation between pump inlet position. Low pressure indication may occur after center tank quantity reads zero. Low pressure light flickering can continue for as long as 5 minutes before the Fuel System Annunciator light and the Master Caution lights are illuminated for the associated center tank pump.

Suction Feed

When main tank fuel pump pressure is low, each engine can draw fuel from its corresponding main tank through a suction feed line that bypasses the pumps. As the airplane climbs, dissolved air is released from the fuel in the tank due to the decrease in air pressure. This air may collect in the suction feed line and restrict fuel flow. At high altitude, thrust deterioration or engine flameout may occur as a result of the fuel flow reduction.

The dissolved air in the fuel tank will eventually deplete after reaching cruise altitude. The depletion time is dependent upon airplane altitude, fuel temperature, and type of fuel. Once the dissolved air is depleted, the engine may be capable of suction feed operation at cruise power.

Fuel Crossfeed

Two independent, engine fuel manifolds provide pressurized fuel to the engines. Each engine has its own engine fuel manifold.

The engine fuel manifolds are interconnected by use of the crossfeed valve. The valve is DC motor operated from the battery bus.

Fuel pressure can be provided from a main tank with operating fuel pumps to both engines by opening the fuel crossfeed valve. Continued crossfeed use will result in a progressive fuel imbalance.

Fuel Shutoff Valves

Spar fuel shutoff valves are located at the engine–mounting wing stations. The valves are DC motor operated from the hot battery bus. The engine high-pressure shutoff valves are fuel actuated, solenoid controlled valves powered from the battery bus. Both the spar fuel shutoff valve and the engine high-pressure shutoff valve close whenever their respective engine fire switch is pulled or engine start lever is placed to CUTOFF.

Center Tank Fuel Scavenge Jet Pump

With the main tank fuel pump No. 1 FWD Switch ON, the center tank fuel scavenge jet pump operates automatically to transfer any remaining center tank fuel to main tank No. 1. Fuel transfer begins when main tank No. 1 quantity is about one-half. Once the fuel scavenge process begins, it continues for the remainder of the flight.

Fuel Temperature

The FUEL TEMP indicator located on the fuel control panel displays fuel temperature. A sensor in main tank No. 1 allows monitoring of fuel temperature. The temperature indicating system uses AC electrical power.

APU Fuel Feed

When AC fuel pumps are operating, fuel for the APU is supplied from the left side of the fuel manifold. If the AC fuel pumps are not operating, fuel is suction fed from main tank No. 1.

Fuel Quantity Indication

The fuel quantity indicating system calculates the usable fuel quantity in each tank. The fuel quantity for each tank, and the total fuel quantity are displayed on the main displays in the flight deck. During refuel operations, each tank has its own refuel panel indicator fuel quantity display. In flight, each tank fuel quantity could show higher or lower than the actual fuel quantity by up to 2.5% due to system accuracy constraints.

Fueling/Defueling/Ground Transfer

Rapid fueling and defueling is accomplished at the single–point pressure fueling station in the right wing. The fueling station is also used for the ground transfer of fuel between tanks.

The manual defueling valve, located outboard of engine No. 2, interconnects the engine feed system and the fueling station. It is opened for defueling and tank to tank transfer operations.

A shutoff system is used during fueling to automatically close the fueling valve in each fuel tank when the tank is full.

Fuel Tank Location and Capacities (Usable Fuel)

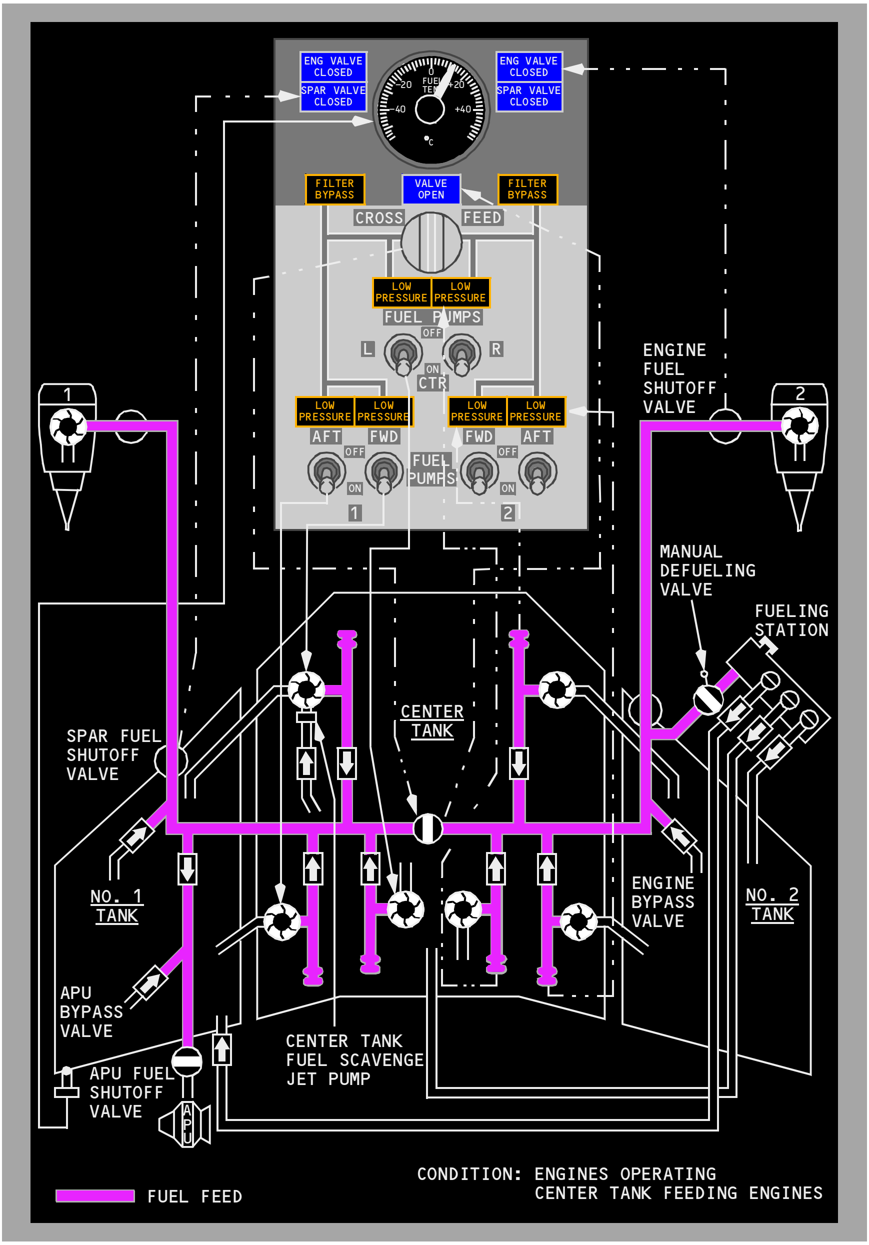
Main tanks No. 1 and No. 2 are integral with the wing structure. The center tank lies between the wing roots within the fuselage area and extends out into the wing structure.

These figures represent approximate amounts of usable fuel. The appropriate weight and balance control and loading manual gives exact figures for all conditions.

TANK	LITERS	KILOGRAMS*
NO. 1	4,819	3,869
NO. 2	4,819	3,869
CENTER	16,179	12,990
TOTAL	25,817	20,728

* Usable fuel at level attitude, fuel density = 0.8029 kilograms per liter

Fuel Schematic



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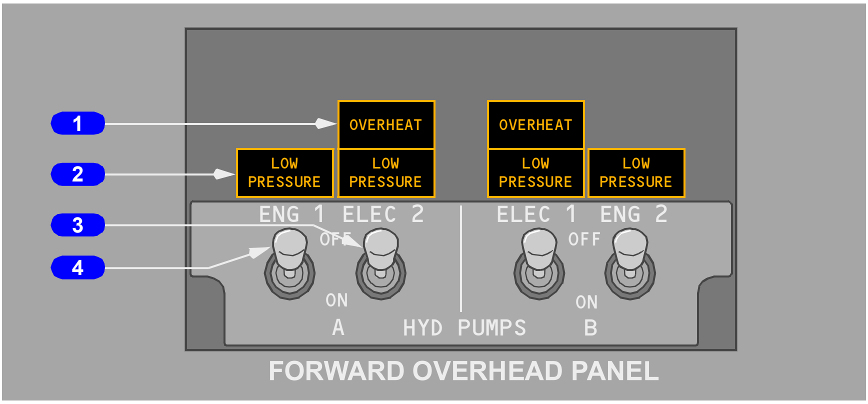
Hydraulic Panel



1 Electric Hydraulic Pump OVERHEAT Lights

Illuminated (amber) – Hydraulic fluid used to cool and lubricate the corresponding electric motor driven pump has overheated or the pump itself has overheated.

2 Hydraulic Pump LOW PRESSURE Lights

Illuminated (amber) – output pressure of associated pump is low.

Note: When an engine fire switch is pulled, the low pressure light is deactivated.

3 ELECTRIC HYDRAULIC PUMPS Switches

ON – provides power to associated electric motor–driven pump.

OFF – electrical power removed from pump.

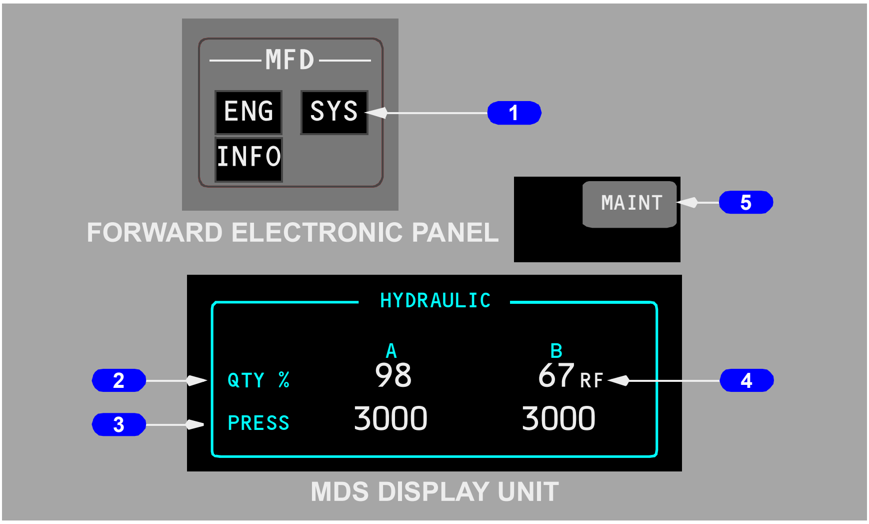
4 ENGINE HYDRAULIC PUMPS Switches

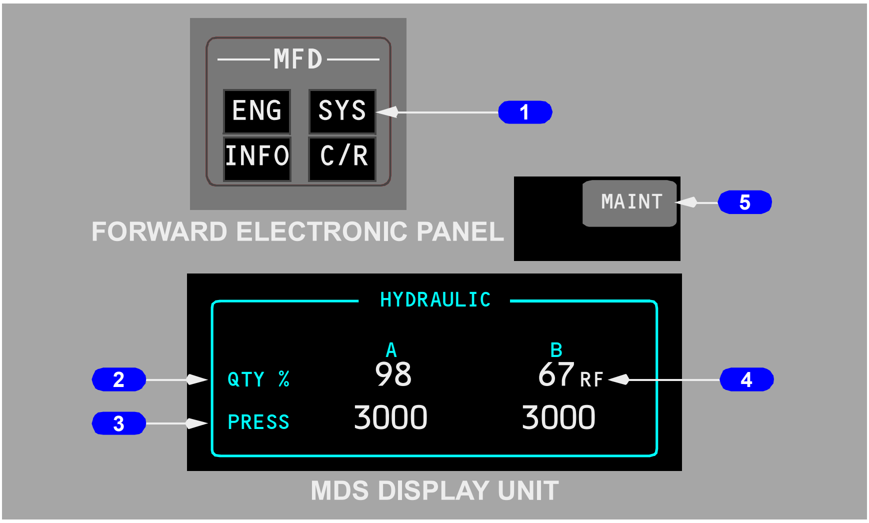
ON – de–energizes blocking valve in pump to allow pump pressure to enter system.

Note: Should remain ON at shutdown to prolong solenoid life.

OFF – energizes blocking valve to block pump output.

Hydraulic Indications





1 MFD System (SYS) Switch

Push – SYS

- displays hydraulic indications on the selected inboard DU.
- second push removes indications from the respective DU.

2 HYDRAULIC System QUANTITY Indications (white)

Indicates digital percentage (0% to 106%) of hydraulic quantity.

Note: Quantity also displayed at each reservoir.

3 HYDRAULIC System PRESSURE Indications (white)

Indicates system pressure:

- Normal pressure – 3000 psi
- Maximum pressure – 3500 psi.

Note: When both pumps for a system are OFF, the indication may read hydraulic system reservoir pressure, normally less than 100 psi.

4 REFILL Indication (RF) (white)

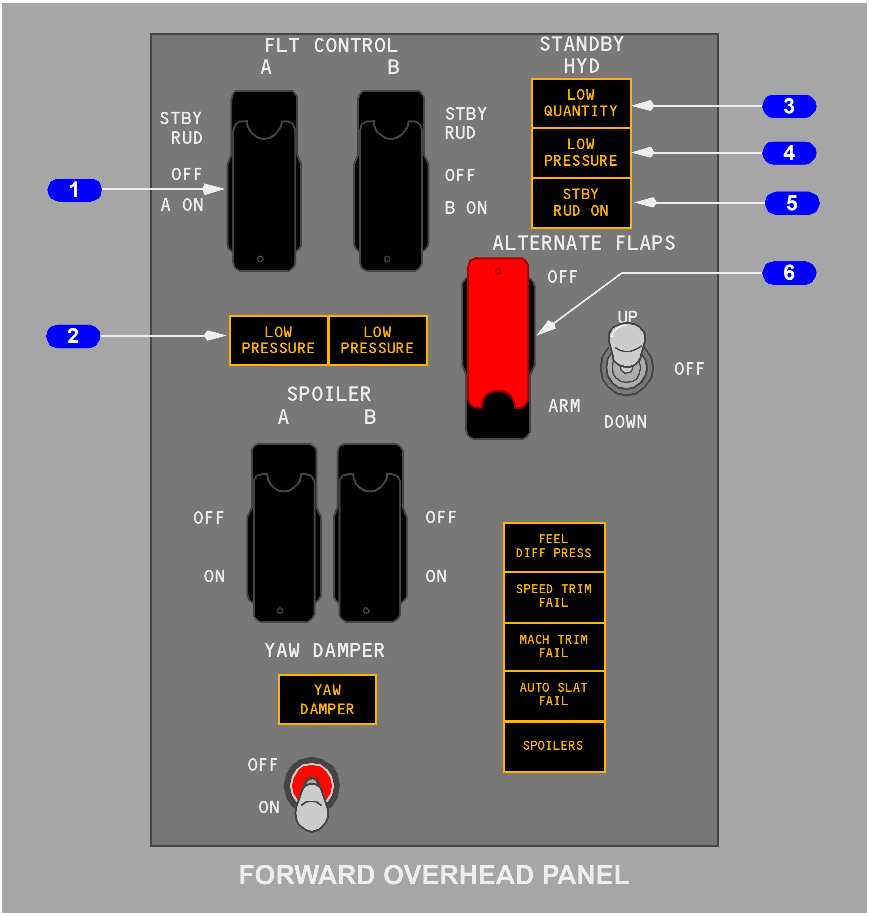
Illuminated (white) – hydraulic quantity below 76%.

Note: Valid only when airplane is on ground with both engines shutdown or after landing with flaps up during taxi–in.

5 Maintenance (MAINT) Menu Tab

The MAINT menu tab is available on the ground and is always shown if the MFD systems (SYS) page is selected. It is not an indication of a malfunction.

Flight Control Panel



1 FLIGHT CONTROL Switches

STBY RUD – activates standby pump and opens standby rudder shutoff valve to pressurize standby rudder power control unit.

OFF – closes flight control shutoff valve isolating ailerons, elevators and rudder from corresponding hydraulic system pressure.

ON (guarded position) – normal operating position.

2 Flight Control LOW PRESSURE Lights

Illuminated (amber) –

- indicates low hydraulic system (A or B) pressure to ailerons, elevator and rudder
- deactivated when associated FLIGHT CONTROL switch is positioned to STBY RUD and standby rudder shutoff valve opens.

3 STANDBY HYDRAULIC LOW QUANTITY Light

Illuminated (amber) –

- indicates low quantity in standby hydraulic reservoir
- always armed.

4 STANDBY HYDRAULIC LOW PRESSURE Light

Illuminated (amber) –

- indicates output pressure of standby pump is low
- armed only when standby pump operation has been selected or automatic standby function is activated.

5 STBY RUD ON Light

Illuminated (amber) - indicates the electric motor driven standby pump is commanded on to pressurize the standby rudder PCU (Power Control Unit).

6 ALTERNATE FLAPS Master Switch

OFF (guarded position) – normal operating position.

ARM – closes trailing edge flap bypass valve, activates standby pump, and arms ALTERNATE FLAPS position switch.

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Introduction

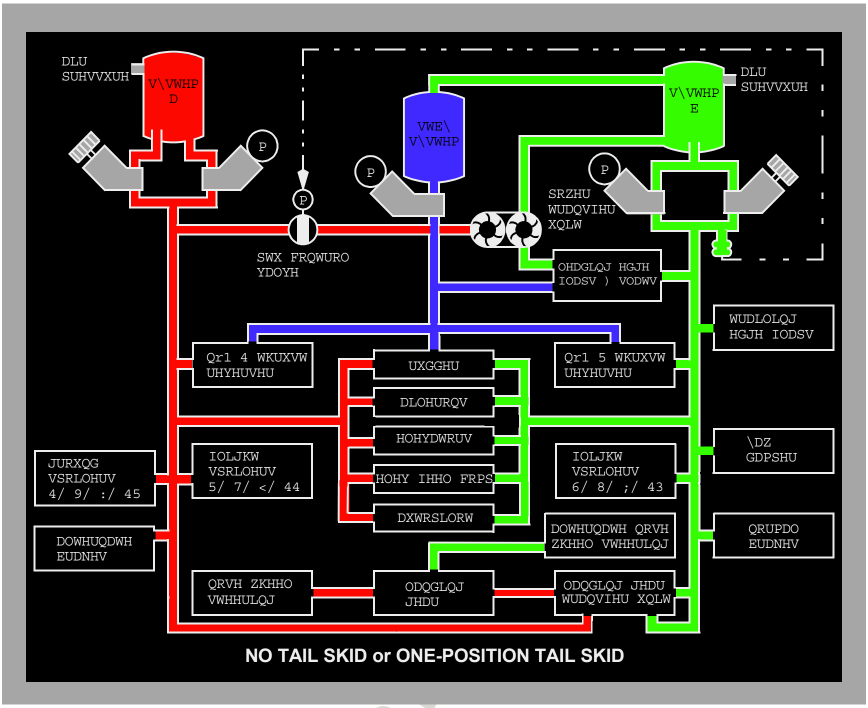
The airplane has three hydraulic systems: A, B and standby. The standby system is used if system A and/or B pressure is lost. The hydraulic systems power the following airplane systems:

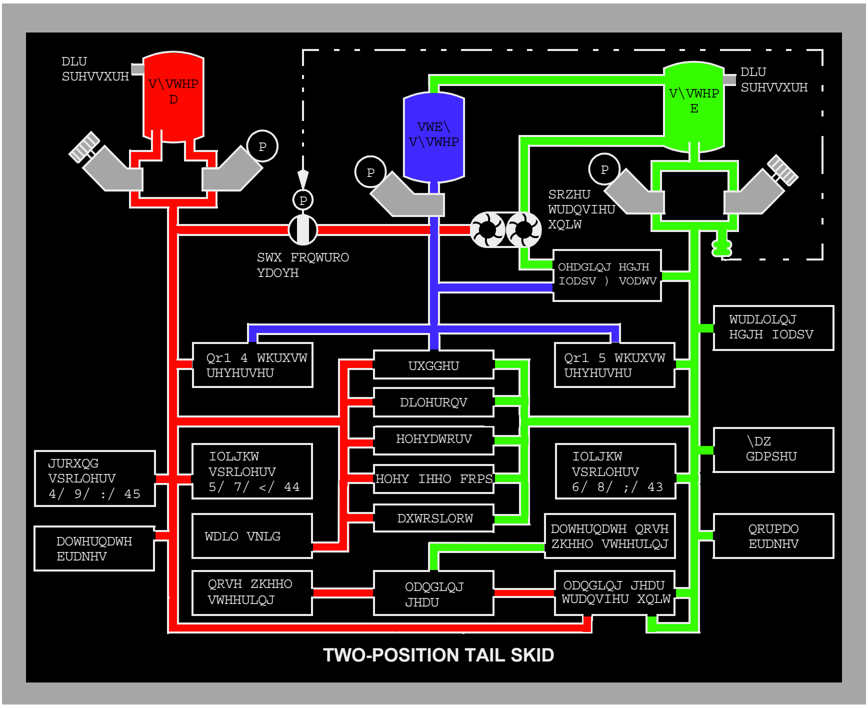
- flight controls
- leading edge flaps and slats
- trailing edge flaps
- landing gear
- wheel brakes
- nose wheel steering
- thrust reversers
- autopilots.

Either A or B hydraulic system can power all flight controls with no decrease in airplane controllability.

Each hydraulic system has a fluid reservoir located in the main wheel well area. System A and B reservoirs are pressurized by bleed air. The standby system reservoir is connected to the system B reservoir for pressurization and servicing. Pressurization of all reservoirs ensures positive fluid flow to all hydraulic pumps.

Hydraulic Power Distribution Schematic





A and B Hydraulic Systems

Components powered by hydraulic systems A and B are:

System A

- ailerons
- rudder
- elevator and elevator feel
- flight spoilers (2,4,9,11)
- ground spoilers (1,6,7,12)
- alternate brakes
- No. 1 thrust reverser
- autopilot A
- normal nose wheel steering
- landing gear
- landing gear transfer valve
- tail skid
- power transfer unit (PTU).

System B

- ailerons
- rudder
- elevator and elevator feel
- flight spoilers (3,5,8,10)
- leading edge flaps and slats
- trailing edge flaps
- normal brakes
- No. 2 thrust reverser
- autopilot B
- alternate nose wheel steering
- landing gear transfer unit
- yaw damper
- power transfer unit (PTU).

A and B Hydraulic System Pumps

Both A and B hydraulic systems have an engine–driven pump and an AC electric motor–driven pump. The system A engine–driven pump is powered by the No. 1 engine and the system B engine–driven pump is powered by the No. 2 engine. An engine–driven hydraulic pump supplies approximately 6 times the fluid volume of the related electric motor–driven hydraulic pump.

The ENG 1 (system A) or ENG 2 (system B) pump ON/OFF switch controls the engine–driven pump output pressure. Positioning the switch to OFF isolates fluid flow from the system components. However, the engine–driven pump continues to rotate as long as the engine is operating. Pulling the engine fire switch shuts off the fluid flow to the engine–driven pump and deactivates the related LOW PRESSURE light.

The ELEC 2 (system A) or ELEC 1 (system B) pump ON/OFF switch controls the related electric motor–driven pump. If an overheat is detected in either system, the related OVERHEAT light illuminates, power is removed from the pump and the LOW PRESSURE light illuminates.

Note: Loss of an engine-driven hydraulic pump and a high demand on the system may result in an intermittent illumination of the LOW PRESSURE light for the remaining electric motor-driven hydraulic pump. The flight control LOW PRESSURE light, Master Caution light, and the FLT CONT and HYD system annunciator lights also illuminate.

Hydraulic fluid used for cooling and lubrication of the pumps passes through a heat exchanger before returning to the reservoir. The heat exchanger for system A is located in main fuel tank No. 1 and for system B is in main fuel tank No. 2.

CAUTION: Minimum fuel for ground operation of electric motor-driven pumps is 760 Kgs in the related main tank.

Pressure switches, located in the engine–driven and electric motor–driven pump output lines, send signals to illuminate the related LOW PRESSURE light if pump output pressure is low. A check valve, located in each output line, isolates the related pump from the system. The related system pressure transmitter sends the combined pressure of the engine–driven and electric motor–driven pumps to the hydraulic pressure indication on the MAX Display System (MDS). The related system fluid quantity is displayed on indicators at the reservoir and on MDS.

System A Hydraulic Leak

If a leak develops in the engine–driven pump or its related lines, a standpipe in the reservoir prevents a total system fluid loss. With fluid level at the top of the standpipe, the reservoir quantity displayed indicates approximately 1/4 full or 20% full on the MDS. System A hydraulic pressure is maintained by the electric motor–driven pump.

If a leak develops in the electric motor–driven pump or its related lines, or components common to both the engine and electric motor–driven pumps, the quantity in the reservoir steadily decreases to zero and all system pressure is lost.

System B Hydraulic Leak

If a leak develops in either pump, line or component of system B, the quantity decreases until it indicates approximately zero and system B pressure is lost. The system B reservoir has one standpipe which supplies fluid to both the engine–driven pump and the electric motor–driven pump. However, with fluid level at the top of the standpipe, fluid remaining in the system B reservoir is sufficient for power transfer unit operation.

A leak in system B does not affect the operation of the standby hydraulic system.

Power Transfer Unit

The purpose of the PTU is to supply the additional volume of hydraulic fluid needed to operate the autoslats and leading edge flaps and slats at the normal rate when system B engine–driven hydraulic pump is inoperative. The PTU uses system A pressure to power a hydraulic motor–driven pump, which pressurizes system B hydraulic fluid. The PTU operates automatically when all of the following conditions exist:

- system B engine–driven pump hydraulic pressure drops below limits
- airborne
- flaps not up.

Landing Gear Transfer Unit

The purpose of the landing gear transfer unit is to supply the volume of hydraulic fluid needed to raise the landing gear at the normal rate when system A engine–driven pump volume is lost. The system B engine–driven pump supplies the volume of hydraulic fluid needed to operate the landing gear transfer unit when all of the following conditions exist:

- airborne
- No. 1 engine RPM drops below a limit value
- landing gear lever is positioned UP
- either main landing gear is not up and locked.

Standby Hydraulic System

The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. The standby system can be activated manually or automatically and uses a single electric motor–driven pump to power:

- thrust reversers
- rudder

- leading edge flaps and slats (extend only)
- standby yaw damper.

Manual Operation

Positioning either FLT CONTROL switch to STBY RUD:

- activates the standby electric motor–driven pump
- shuts off the related hydraulic system pressure to ailerons, elevators and rudder by closing the flight control shutoff valve
- opens the standby rudder shutoff valve
- deactivates the related flight control LOW PRESSURE light when the standby rudder shutoff valve opens
- allows the standby system to power the rudder and thrust reversers.
- illuminates the STBY RUD ON, Master Caution, and Flight Controls (FLT CONT) lights.

Positioning the ALTERNATE FLAPS master switch to ARM, (refer to Chapter 9, Flight Controls for a more complete explanation):

- activates the standby electric motor–driven pump
- closes the trailing edge flap bypass valve
- arms the ALTERNATE FLAPS position switch
- allows the standby system to power the leading edge flaps and slats and thrust reversers.

Automatic Operation

Automatic operation is initiated when the following conditions exist:

- loss of system A or B, and
- flaps extended, and
- airborne, or wheel speed greater than 60 kts, and
- FLT CONTROL switch A or B Hydraulic System ON

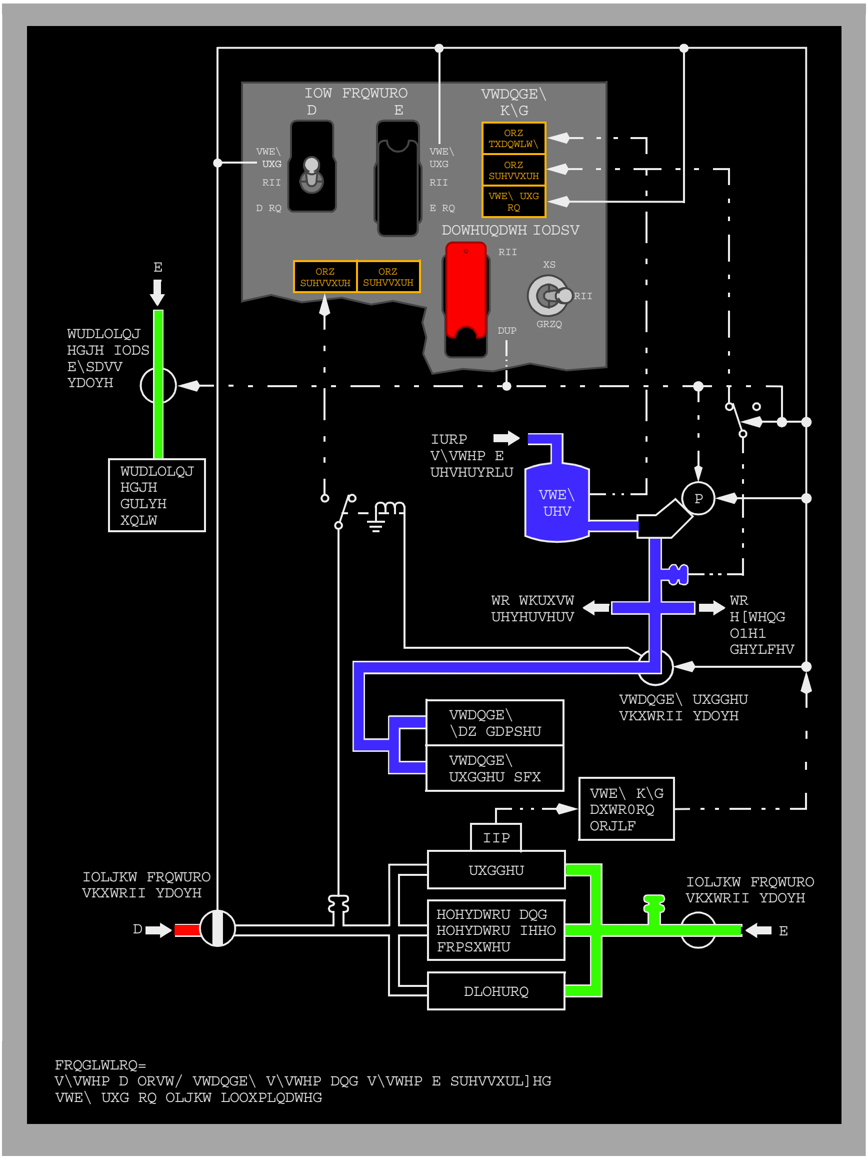
OR:

- the main PCU Force Fight Monitor (FFM) trips

Automatic operation:

- activates the standby electric motor–driven pump
- opens the standby rudder shutoff valve
- allows the standby system to power the rudder and thrust reversers.
- illuminates the STBY RUD ON, Master Caution, and Flight Controls (FLT CONT) lights.

Standby Hydraulic System Schematic



Standby Hydraulic System Leak

If a leak occurs in the standby system, the standby reservoir quantity decreases to zero. The LOW QUANTITY light illuminates when the standby reservoir is approximately half empty. System B continues to operate normally, however, the system B reservoir fluid level indication decreases and stabilizes at approximately 70% full.

Variations in Hydraulic Quantity Indications

During normal operations, variations in hydraulic quantity indications occur when:

- the system becomes pressurized after engine start
- raising or lowering the landing gear or leading edge devices
- cold soaking occurs during long periods of cruise.

These variations have little effect on systems operation.

If the hydraulic system is not properly pressurized, foaming can occur at higher altitudes. Foaming can be recognized by pressure fluctuations and the blinking of the related LOW PRESSURE lights. The MASTER CAUTION and HYD annunciator lights may also illuminate momentarily.

Landing Gear — Chapter 14

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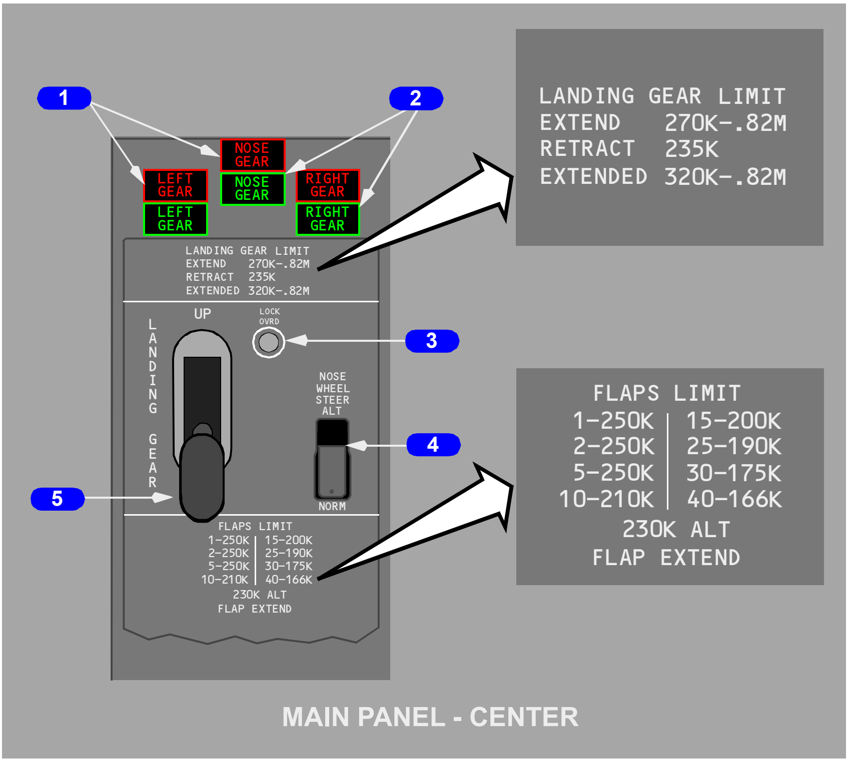
Landing Gear Panel



1 Landing Gear Indicator Lights (top)

Illuminated (red) –

- landing gear is not down and locked (with either or both forward thrust levers retarded to idle, and below 800 feet AGL)
- related landing gear is in disagreement with LANDING GEAR lever position (in transit or unsafe).

Extinguished -

- landing gear is up and locked with landing gear lever UP
- landing gear is down and locked with landing gear lever DN.

2 Landing Gear Indicator Lights (bottom)

Illuminated (green) – related gear down and locked.

Note: Landing gear warning horn is deactivated with all gear down and locked.

Note: Landing gear is down and locked as long as one green landing gear indicator light (center panel or overhead panel) for each gear is illuminated.

Extinguished – landing gear is not down and locked.

3 Landing Gear Lever Lock Override (LOCK OVRD) Switch

Push – releases the landing gear lever lock.

4 NOSE WHEEL STEER Switch

ALT – hydraulic system B provides power for nose wheel steering.

NORM (guarded position) – hydraulic system A provides power for nose wheel steering.

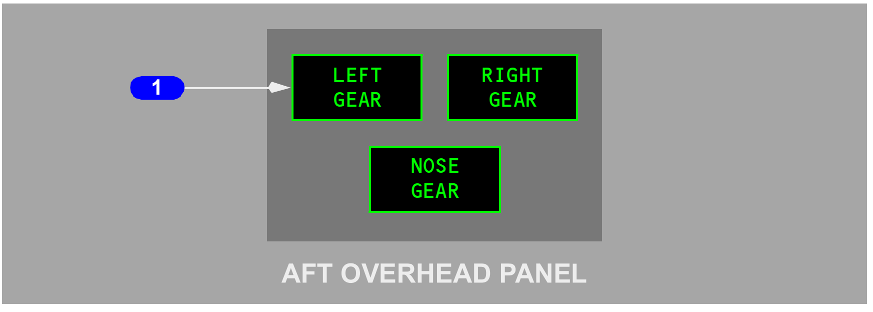
5 LANDING GEAR Lever

UP – landing gear retract.

DN – landing gear extend.

Landing Gear Indicator Lights

This is a redundant but separate set of landing gear indicator circuits and lights.



1 Landing Gear Indicator Lights (overhead)

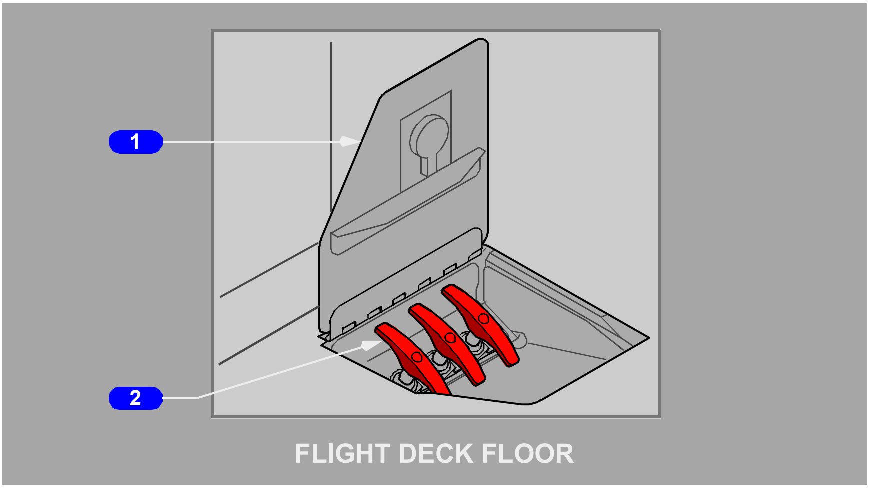
Illuminated (green) – related gear down and locked.

Note: Landing gear warning horn is deactivated with all gear down and locked.

Note: Landing gear is down and locked as long as one green landing gear indicator light (center panel or overhead panel) for each gear is illuminated.

Extinguished – landing gear is not down and locked.

Manual Gear Extension



1 Manual Extension Access Door

Open –

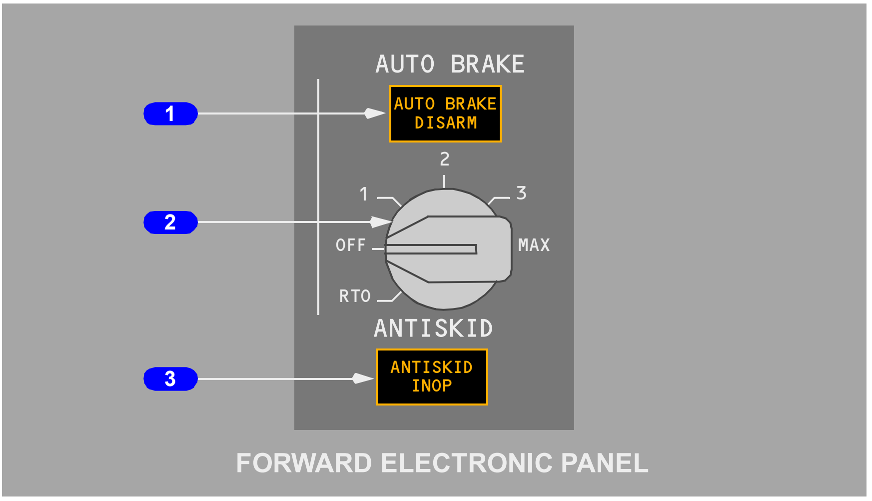
- manual landing gear extension is possible with landing gear lever in any position
- normal landing gear extension is still possible if hydraulic system A pressure is available
- landing gear retraction is disabled.

Closed – landing gear operate normally.

2 Manual Gear Extension Handles

Right main, nose, left main – Each landing gear uplock is released when related handle is pulled to its limit, approximately 24 inches (61 cm).

Autobrake and Antiskid Controls



1 AUTO BRAKE DISARM Light

Illuminated (amber) –

- SPEED BRAKE lever moved to down detent during RTO or landing
- manual brakes applied during RTO or landing
- thrust lever(s) advanced during RTO or landing
  - except during first 3 seconds after touchdown for landing
- landing made with RTO selected
- RTO mode selected on ground
  - illuminates for one to two seconds then extinguishes
- a malfunction exists in automatic braking system.

Extinguished –

- AUTO BRAKE select switch set to OFF
- autobrake armed.

2 AUTO BRAKE Select Switch

OFF – autobrake system deactivated.

1, 2, 3, or MAX –

- selects desired deceleration rate for landing
- switch must be pulled out to select MAX deceleration.

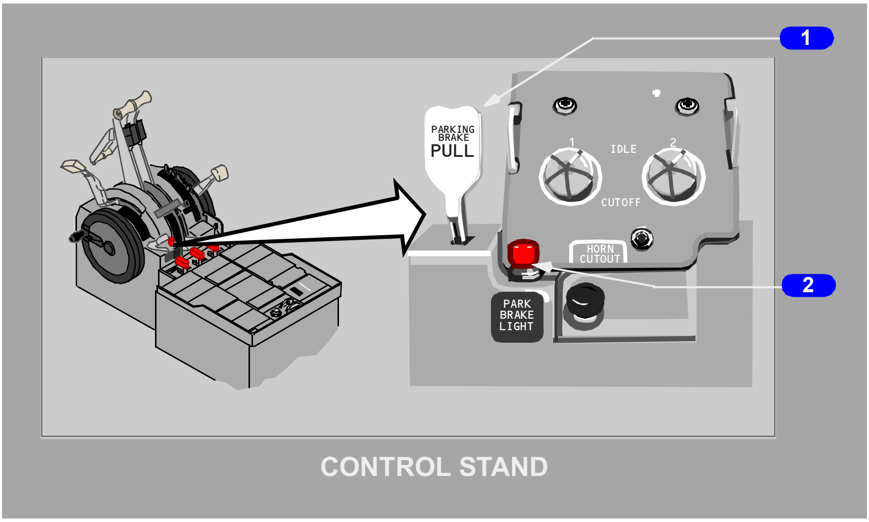
RTO – automatically applies maximum brake pressure when thrust levers are retarded to idle at or above 90 knots.

3 Antiskid Inoperative (ANTISKID INOP) Light

Illuminated (amber) – a system fault is detected by antiskid monitoring system.

Extinguished – antiskid system operating normally.

Parking Brake



1 PARKING BRAKE Lever

Forward – parking brakes released.

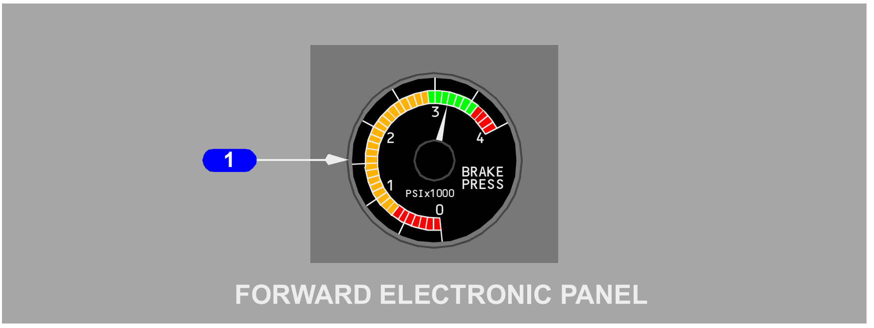
Aft – sets parking brakes when either Captain’s or First Officer’s brake pedals are fully depressed.

2 Parking Brake Warning Light

Illuminated (red) – parking brake is set (light operates from battery power).

Extinguished – parking brake is released.

Hydraulic Brake Pressure Indicator



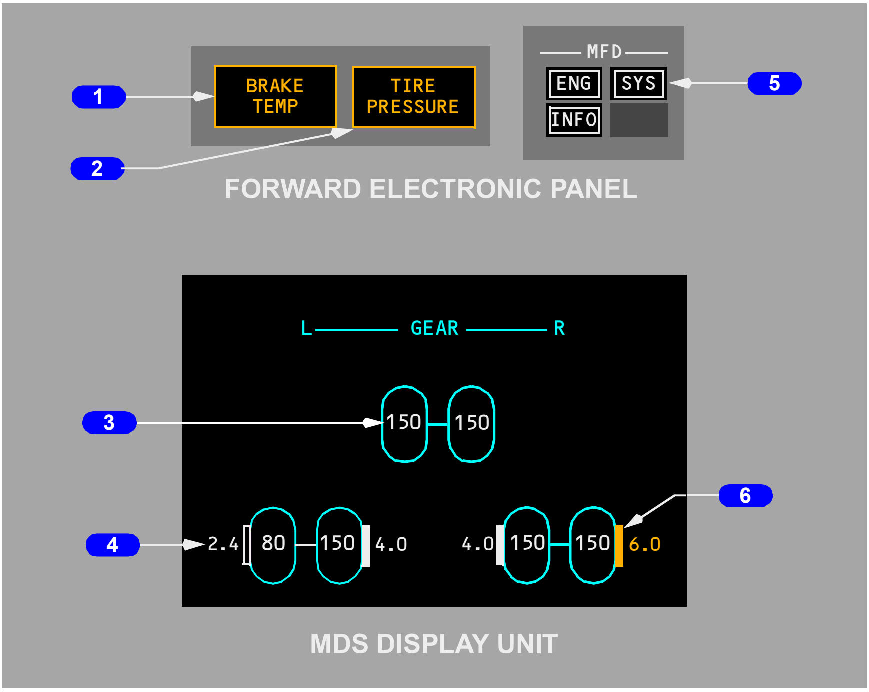
1 Hydraulic Brake Pressure (HYD BRAKE PRESS) Indicator

Indicates brake accumulator pressure:

- normal pressure – 3000 psi
- maximum pressure – 3500 psi
- normal precharge – 1000 psi.

Brake Temperature/Tire Pressure Indicator

(as installed)



1 Brake Temperature (BRAKE TEMP) Light

Illuminated (amber) -

- temperature of one or more brakes exceed 4.9 (standard BTMS) or exceeds overheat temperature threshold (adaptive BTMS)
- extinguishes when a hot brake condition is no longer indicated on the display unit.

2 Tire Pressure (TIRE PRESSURE) Light

Illuminated (amber) -

- a main or nose gear tire pressure falls below 100 psi
- a differential pressure exists between two main gear tires on the same axle, greater than 25% of the lower tire pressure
- a differential pressure exists between nose gear tires greater than 12% of the lower tire pressure

3 **Tire Pressure**

Indicates individual tire pressure

- displayed (white) - normal tire pressure condition
- displayed (amber) - abnormal tire pressure condition.

4 **Brake Temperature**

Indicates a relative value of wheel brake temperature

- values range from 0.0 to 9.9
- displayed (white) - normal brake temperature range
- displayed (amber) - high brake temperature, exceeds.

5 **MFD System (SYS) Switch**

Push – SYS

- displays brake temperature and tire pressure indications on the selected DU.
- second push removes indications from the respective DU.

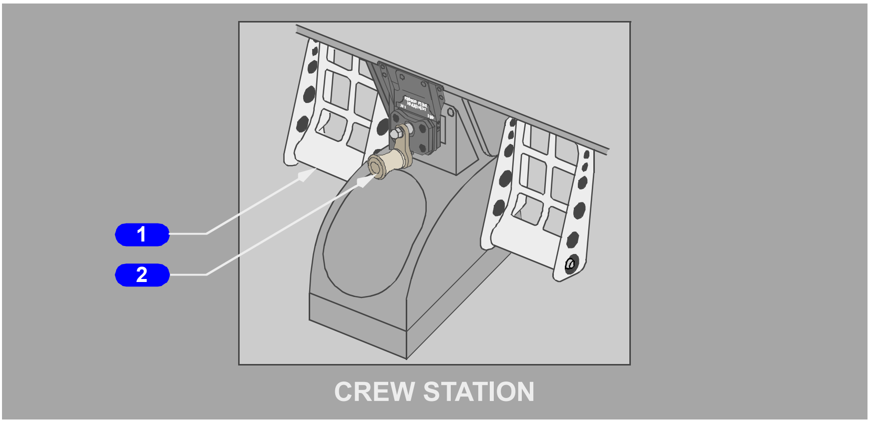
6 **Brake Symbol**

Displayed (blank) - indicates any brake less than 2.5.

Displayed (solid white) - indicates the hottest brake on each main gear truck, within the range of 2.5 to 4.9.

Displayed (solid amber) - indicates brake overheat condition on each wheel within the range of 5.0 to 9.9. Symbol remains until value is less than 3.5.

Rudder/Brake Pedals



1 Rudder/Brake Pedals

Push full pedal – turns nose wheel up to 6 degrees in either direction.

Push top of pedal only – activates wheel brakes.

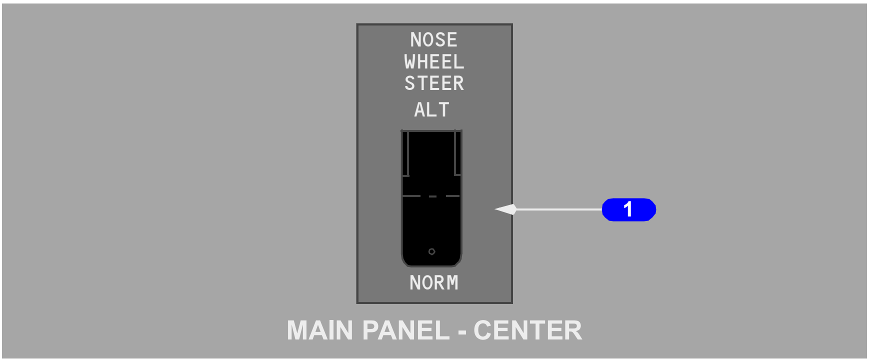
Refer to Chapter 9 Flight Controls for rudder description.

2 RUDDER PEDAL ADJUSTMENT Crank

AFT (counter–clockwise) – adjusts rudder pedals aft.

FWD (clockwise) – adjusts rudder pedals forward.

Nose Wheel Steer Switch

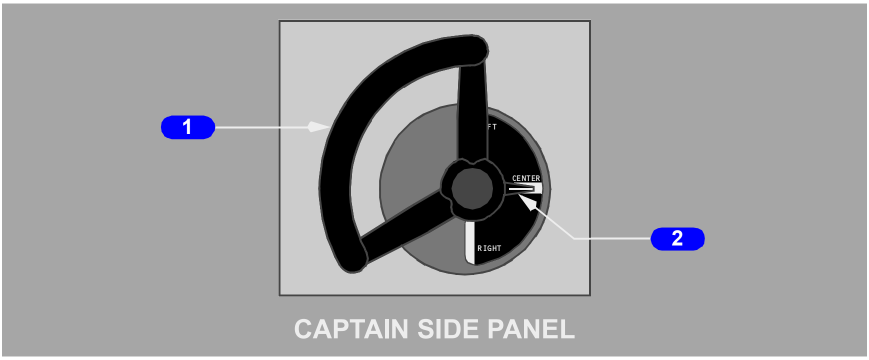


1 NOSE WHEEL STEER Switch

ALT – hydraulic system B provides power for nose wheel steering.

NORM (guarded position) – hydraulic system A provides power for nose wheel steering.

Nose Wheel Steering Wheel



1 Nose Wheel Steering Wheel

Rotate –

- turns nose wheel up to 78 degrees in either direction

  Note: Refer to Chapter 1 for effective steering angle and turning radius.

- overrides rudder pedal steering.

2 Nose Wheel Steering Indicator

LEFT – indicates nose wheel steering displacement left of center position.

CENTER – normal straight ahead position.

RIGHT – indicates nose wheel steering displacement right of center position.

Introduction

The airplane has two main landing gear and a single nose gear. Each main gear is a conventional two–wheel landing gear unit. The nose gear is a conventional steerable two–wheel unit.

Hydraulic power for retraction, extension, and nose wheel steering is normally supplied by hydraulic system A. A manual landing gear extension system and an alternate source of hydraulic power for nose wheel steering are also provided.

The normal brake system is powered by hydraulic system B. The alternate brake system is powered by hydraulic system A. Antiskid protection is provided on both brake systems, but the autobrake system is available only with the normal brake system.

A brake temperature monitoring system (as installed) displays each main landing gear brake temperature on the selected MDS DU.

A tire pressure monitoring system (as installed) displays the pressure of each tire on the selected MDS DU.

Landing Gear Operation

The landing gear are normally controlled by the LANDING GEAR lever. On the ground, a landing gear lever lock prevents the LANDING GEAR lever from moving to the up position. The LOCK OVRD pushbutton may be used to bypass the landing gear lever lock. In flight, the air/ground system energizes a solenoid which opens the lever lock.

Landing Gear Retraction

When the LANDING GEAR lever is moved to UP, the landing gear begins to retract. During retraction, the brakes automatically stop rotation of the main gear wheels. After retraction, the main gear are held in place by mechanical uplocks. Rubber seals and oversized hubcaps complete the fairing of the outboard wheels.

The nose wheels retract forward into the wheel well and nose wheel rotation is stopped by snubbers. The nose gear is held in place by an overcenter lock and enclosed by doors which are mechanically linked to the gear.

Hydraulic pressure is removed from the landing gear system by the PSEU 10 seconds after all gear are up and locked.

If a main landing gear tire is damaged during takeoff, it is possible that braking of the main gear wheels during retraction may be affected. A spinning tire with a loose tread must be stopped prior to entering the wheel well or it can cause damage to wheel well components. When a spinning tire with loose tread impacts a fitting in the wheel well ring opening, that gear stops retracting and free falls back to the down position. The affected gear cannot be retracted until the fitting is replaced.

Landing Gear Transfer Unit

Hydraulic system B pressure is available for raising the landing gear through the landing gear transfer unit. Hydraulic system B supplies the volume of hydraulic fluid required to raise the landing gear at the normal rate when all of the following conditions exist:

- airborne
- No. 1 engine RPM drops below a limit value
- LANDING GEAR lever is positioned UP
- either main landing gear is not up and locked.

Landing Gear Extension

When the LANDING GEAR lever is moved to DN, hydraulic system A pressure is used to release the uplocks. The landing gear extends by hydraulic pressure, gravity and air loads. Overcenter mechanical and hydraulic locks hold the gear at full extension. The nose wheel doors remain open when the gear is down.

Landing Gear Manual Extension

If hydraulic system A pressure is lost, the manual extension system provides another means of landing gear extension. Manual gear releases on the flight deck are used to release uplocks that allow the gear to free–fall to the down and locked position. The forces that pull the gear down are gravity and air loads.

With the manual extension access door open:

- manual landing gear extension is possible with the LANDING GEAR lever in either position
- normal landing gear extension is possible if hydraulic system A pressure is available
- landing gear retraction is disabled.

Following a manual extension, the landing gear may be retracted normally by accomplishing the following steps:

- close the manual extension access door
- move the LANDING GEAR lever to DOWN with hydraulic system A pressure available, and then
- position the LANDING GEAR lever to UP.

Nose Wheel Steering

Nose wheel steering is available when the nose gear is in the down position and compressed by weight of the airplane. Positioning the landing gear control lever to down makes system A hydraulic pressure available to the steering metering valve. Alternate nose wheel steering can be activated to provide system B pressure to the nose wheels when the NOSE WHEEL STEER switch is placed to ALT, normal quantity is in the system B reservoir, and the airplane is on the ground. In the event of a hydraulic leak downstream of the Landing Gear Transfer Unit, resulting in a loss of hydraulic system B fluid in the reservoir, a sensor closes the Landing Gear Transfer Valve and alternate steering will be lost.

Primary steering is controlled through the nose wheel steering wheel. Limited steering control is available through the rudder pedals. A pointer on the nose steering wheel assembly shows nose wheel steering position relative to the neutral setting. Rudder pedal steering is deactivated as the nose gear strut extends.

A lockout pin may be installed in the towing lever to depressurize nose wheel steering. This allows airplane pushback or towing without depressurizing the hydraulic systems.

Brake System

Each main gear wheel has a multi–disc hydraulic powered brake. The brake pedals provide independent control of the left and right brakes. The nose wheels have no brakes. The brake system includes:

- normal brake system
- alternate brake system
- brake accumulator
- antiskid protection
- autobrake system
- parking brake
- brake temperature indication

Normal Brake System

The normal brake system is powered by hydraulic system B.

Alternate Brake System

The alternate brake system is powered by hydraulic system A. If hydraulic system B is low or fails, hydraulic system A automatically supplies pressure to the alternate brake system.

Brake Accumulator

The brake accumulator is pressurized by hydraulic system B. If both normal and alternate brake system pressure is lost, trapped hydraulic pressure in the brake accumulator can still provide several braking applications or parking brake application.

Antiskid Protection

Antiskid protection is provided in the normal and alternate brake systems.

The normal brake hydraulic system provides each main gear wheel with individual antiskid protection. When the system detects a skid, the associated antiskid valve reduces brake pressure until skidding stops. The alternate brake hydraulic system works similar to the normal system however antiskid protection is applied to main gear wheel pairs instead of individual wheels.

Both normal and alternate brake systems provide skid, locked wheel, touchdown and hydroplane protection.

Antiskid protection is available even with loss of both hydraulic systems.

Autobrake System

The autobrake system uses hydraulic system B pressure to provide maximum deceleration for rejected takeoff and automatic braking at preselected deceleration rates immediately after touchdown. The system operates only when the normal brake system is functioning. Antiskid system protection is provided during autobrake operation.

Rejected Takeoff (RTO)

The RTO mode can be selected only when on the ground. Upon selection, the AUTO BRAKE DISARM light illuminates for one to two seconds and then extinguishes, indicating that an automatic self–test has been successfully accomplished.

To arm the RTO mode prior to takeoff the following conditions must exist:

- airplane on the ground
- antiskid and autobrake systems operational
- AUTO BRAKE select switch positioned to RTO
- wheel speed less than 60 knots
- forward thrust levers positioned to IDLE.

With RTO selected, if the takeoff is rejected prior to wheel speed reaching 88 knots autobraking is not initiated, the AUTO BRAKE DISARM light does not illuminate and the RTO autobrake function remains armed. If the takeoff is rejected after reaching a wheel speed of 88 knots, maximum braking is applied automatically when the forward thrust levers are retarded to IDLE.

The RTO mode is automatically disarmed when both air/ground systems indicate the air mode. The AUTO BRAKE DISARM light does not illuminate and the AUTO BRAKE select switch remains in the RTO position. To reset or manually disarm the autobrake system, position the selector to OFF. If a landing is made with RTO selected (AUTO BRAKE select switch not cycled through OFF), no automatic braking action occurs and the AUTO BRAKE DISARM light illuminates two seconds after touchdown.

Landing

When a landing autobrake selection is made, the system performs a turn–on–self–test. If the turn–on–self–test is not successful, the AUTO BRAKE DISARM light illuminates and the autobrake system does not arm.

Four levels of deceleration can be selected for landing. However, on dry runways, the maximum autobrake deceleration rate in the landing mode is less than that produced by full pedal braking.

After landing, autobrake application begins when:

- both forward thrust levers are retarded to IDLE
- the main wheels spin–up.

Note: Landing autobrake settings may be selected after touchdown prior to decelerating through 30 kts of ground speed. Braking initiates immediately if the above conditions are met.

To maintain the selected landing deceleration rate, autobrake pressure is reduced as other controls, such as thrust reversers and spoilers, contribute to total deceleration. The deceleration level can be changed (without disarming the system) by rotating the selector. The autobrake system brings the airplane to a complete stop unless the braking is terminated by the pilot.

Autobrake – Disarm

The pilots may disarm the autobrake system by moving the selector switch to the OFF position. This action does not cause the AUTO BRAKE DISARM light to illuminate. After braking has started, any of the following pilot actions disarm the system immediately and illuminate the AUTO BRAKE DISARM light:

- moving the SPEED BRAKE lever to the down detent
- advancing the forward thrust lever(s), except during the first 3 seconds after touchdown for landing
- applying manual brakes.

Parking Brake

The parking brake can be set with either A or B hydraulic systems pressurized. If A and B hydraulic systems are not pressurized, parking brake pressure is maintained by the brake accumulator. Accumulator pressure is shown on the HYD BRAKE PRESS indicator.

The parking brake is set by depressing both brake pedals fully, while simultaneously pulling the PARKING BRAKE lever up. This mechanically latches the pedals in the depressed position and commands the parking brake valve to close.

The parking brake is released by depressing the pedals until the PARKING BRAKE lever releases. A fault in the parking brake system may cause the ANTISKID INOP light to illuminate.

The TAKEOFF CONFIG lights illuminate and the takeoff configuration warning horn sounds if either forward thrust lever is advanced for takeoff with the parking brake set.

Brake Temperature Monitoring System

(as installed)

The temperatures of each main landing gear (MLG) brake are displayed on the MDS System page. If any of the brake temperatures correspond with an overheated brake, the temperature value for that brake as well as the associated brake symbol turn amber, and the BRAKE TEMP light on the forward electronic panel illuminates.

Tire Pressure Monitoring System

(as installed)

Tire pressures of each main landing gear (MLG) and nose landing gear (NLG) tire are displayed on the MDS System page. When an abnormal tire pressure condition exists, the display turns to amber, and the TIRE PRESSURE light on the forward electronic panel illuminates. Abnormal conditions are defined by low pressure; a 25% difference between MLG tires on the same axle; or a 12% difference between NLG tires.

Air/Ground System

In flight and ground operation of various airplane systems are controlled by the air/ground system.

The system receives air/ground logic signals from six sensors, two on each landing gear. These signals are used to configure the airplane systems to the appropriate air or ground status.

Air/Ground System Logic Table

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
Emergency Exit Doors	Flight locks engaged when either engine N2 is more than 50% and 3 or more Entry/Service doors are closed.	Flight locks disengaged when either thrust lever is set below approximately 53 degrees.	1
Pack Valves	With one pack operating, regulates to high flow with flaps up.	With one pack operating, regulates to high flow only when pack is operating from the APU and both engine bleed switches are OFF.	2
Pressurization	Allows programmed pressurization in the automatic modes.	Allows pressurization only at high power settings.	2
Ram Air	Ram Air fans operate whenever air conditioning packs operate.	Ram Air fans operate whenever air conditioning packs operate. Deflectors are extended.	2

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
Wing Anti–ice	Control valves open when switch is ON. Thrust setting and duct temperature logic is bypassed.	With switch ON, valves cycle open and closed. Switch trips to OFF at lift–off.	3
Autothrottle	Enables go–around below 2000 ft radio altitude.	Disengaged 2 seconds after landing. Takeoff mode enabled.	4
TO/GA switch	Flight director engages go–around mode.	Flight director engages takeoff mode.	4
ACARS	Sends out signal on strut extension for takeoff signal.	Sends out signal on strut compression for landing signal.	5
Voice Recorder	Prevents tape erasure.	Allows tape erasure when parking brake is set.	5
Engine Idle Control	Enables minimum flight idle.	Enables minimum ground idle.	7
Thrust Reverser	Thrust reverse disabled.	Thrust reverse enabled.	7
APU Fire Horn	Wheel well horn disabled.	Wheel well horn enabled.	8
Cargo Fire Protection	Second extinguishing bottle timer enabled.	Second extinguishing bottle timer disabled.	8
Speed Brake Lever Actuator	Can be armed to raise ground spoilers for landing.	Activates SPEED BRAKE lever on landing if armed. Rejected take–off feature available. Drives to DOWN when thrust lever advanced.	9
Auto Slat	System enabled with flaps 1, 2, 5, 10, 15 or 25 selected. PTU available if system B pressure is lost.	System disabled.	9

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
Flight Recorder	Operates anytime electrical power is available.	Operates anytime electrical power is available and either engine is operating.	10
FMC	FMC position updated from GPS, DME or VOR/DME.	FMC position updated from GPS.	11
Standby Hydraulic	Pump automatic operation with flaps extended and A or B pressure lost.	Wheel speed must be greater than 60 knots for automatic operation.	13
Antiskid	Releases normal or alternate brakes for touchdown protection.	Allows normal antiskid braking after wheel spin–up.	14
Autobrake	Allows selection of landing mode.	RTO mode available and landing mode may be selected after touchdown if wheel speed is greater than 30 knots.	14
Landing Gear Lever Lock	Lever lock solenoid released.	Lever lock solenoid latched.	14
Landing Gear Transfer Unit	Enabled.	Disabled.	14
Stall Warning	Enabled.	Disabled.	15
Takeoff Warning	Disabled.	Enabled.	15

Intentionally
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Warning Systems — Chapter 15
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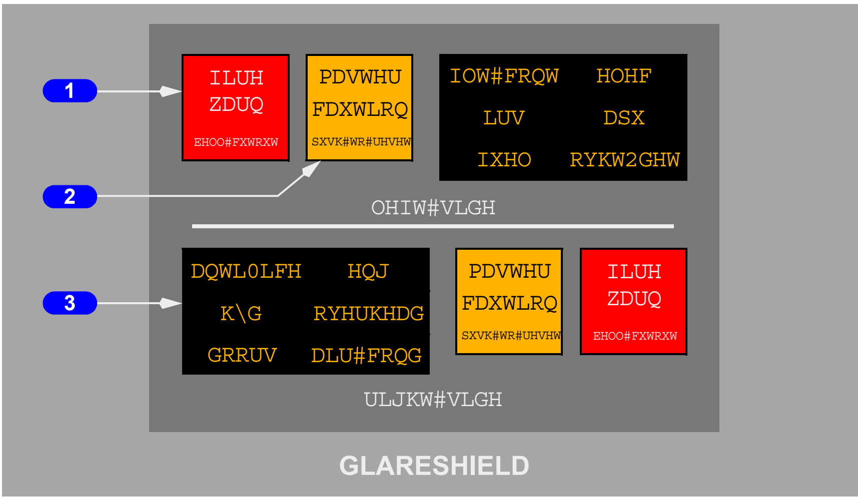
Fire Warning and Master Caution System



1 Master Fire Warning (FIRE WARN) Lights

Illuminated (red) – indicates a fire warning (or system test) in one or more of the following:

- engine
- APU
- main wheel well
- cargo

Associated aural alarms include:

- fire warning bell
- if on ground, remote APU fire warning horn.

Push – extinguishes both master FIRE WARN lights

- silences fire warning bell
- silences remote APU fire warning horn
- resets system for additional warnings.

Note: Pushing fire warning bell cutout switch on overheat/fire protection panel results in the same actions.

2 MASTER CAUTION Lights

Illuminated (amber) – a system annunciator light has illuminated.

Push – extinguishes both MASTER CAUTION lights

- system annunciator light(s) extinguish
- resets system for additional master caution conditions.

3 System Annunciator Panel

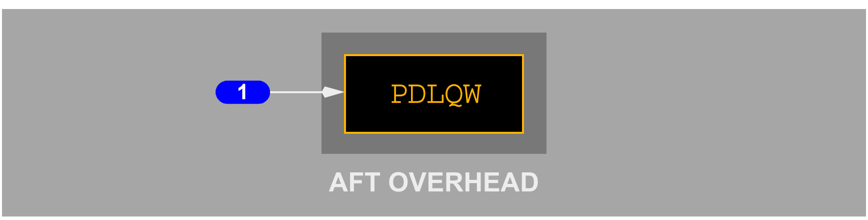
Illuminated (amber) – an amber light, relating to illuminated system annunciator, has illuminated on forward overhead, aft overhead or overheat/fire protection panel.

To extinguish – push either MASTER CAUTION light.

To recall – push and release either system annunciator panel

- if a master caution condition exists, appropriate system annunciator(s) and MASTER CAUTION lights illuminate
- a single fault in certain redundant systems, or some simple faults, cause the system annunciator light to illuminate during a recall. The system annunciator light will extinguish when the MASTER CAUTION light is pushed.

Maintenance Light

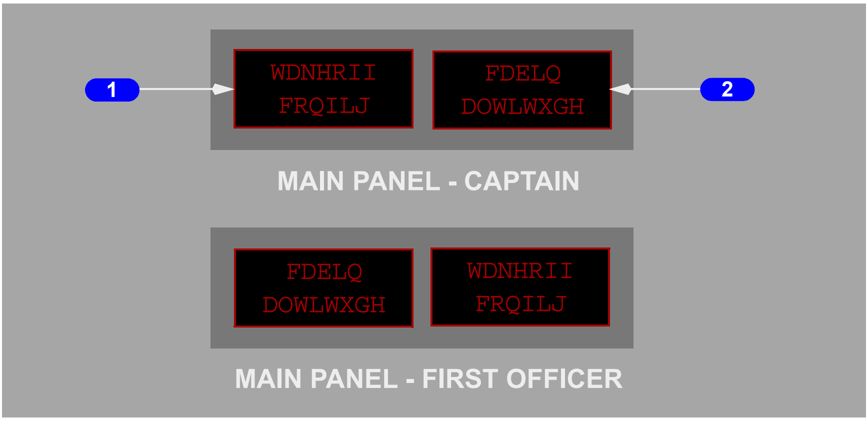


1 Maintenance (MAINT) light

Illuminated (amber) – a system fault exists that must be reviewed by maintenance. Inhibited from first engine start until 30 seconds after landing.

Note: This light is not to be confused with the MAINT menu tab located on the MFD systems (SYS) page. Refer to Chapter 13, Hydraulics.

Takeoff Configuration and Cabin Altitude Warning Lights



1 Takeoff Configuration Warning Light

Illuminated (red) –

- activates on the ground as the throttles are advanced if the airplane is not configured correctly for takeoff
- activation is simultaneous with aural warning intermittent horn for TAKEOFF CONFIGURATION alert.

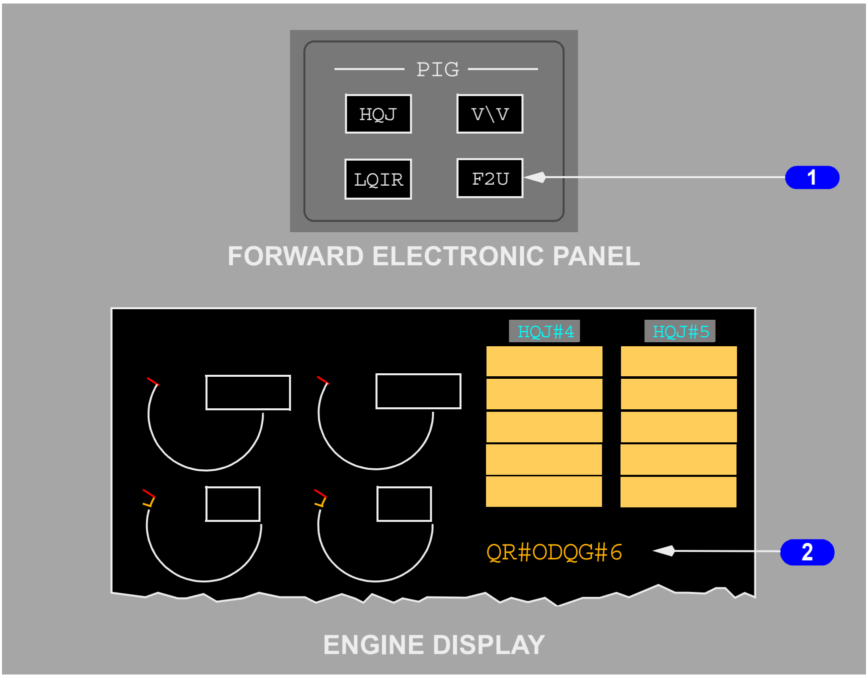
2 Cabin Altitude Warning Light

Illuminated (red) –

- illuminates when cabin altitude exceeds 10,000 feet
- activation is simultaneous with aural warning intermittent horn for CABIN ALTITUDE alert
- extinguishes when cabin altitude descends below 10,000 feet.

Autoland Advisory Message Display

(as installed)



1 MFD Cancel/Recall (C/R) Switch

Push (once) – Cancels autoland advisory messages.

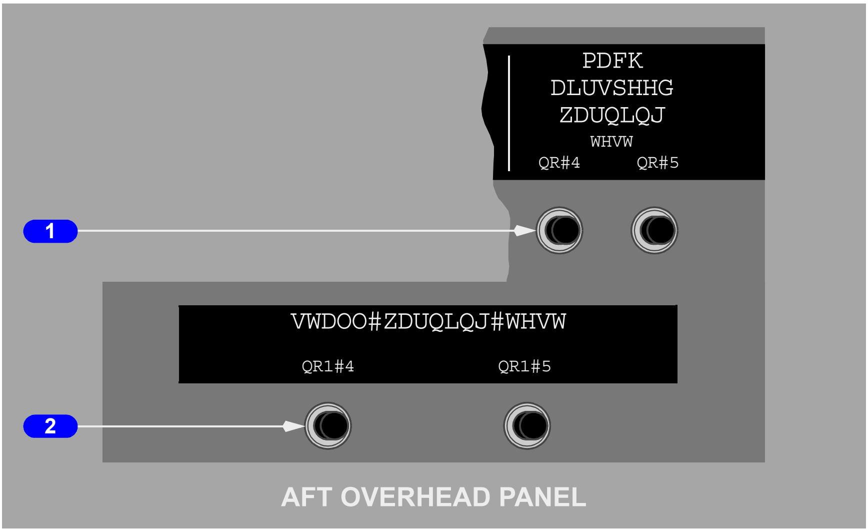
Push (again) – Recalls autoland advisory messages.

2 Autoland Advisory Message

An amber autoland advisory message appears on the engine display when a system fault affects autoland status. Two advisories are available:

- NO LAND 3 – the system is still capable of continuing to a safe landing. A system failure has occurred above Alert Height, and a green LAND 2 status annunciation appears on the Capt and F/O outboard display unit.
- NO AUTOLAND – the system is not capable of performing an automatic landing. A system failure has occurred above Alert Height, and an amber NO AUTOLAND status annunciation appears on the Capt and F/O outboard display unit.

Mach/Airspeed Warning and Stall Warning Test Switches



1 MACH AIRSPEED WARNING TEST Switches

Push – tests respective mach/airspeed warning system

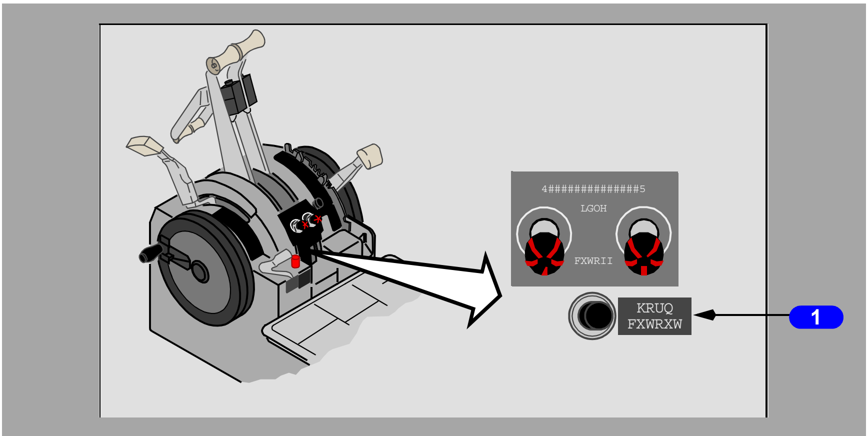
- clacker sounds
- inhibited while airborne.

2 STALL WARNING TEST Switches

Push – on ground with AC power available: Each test switch tests its respective stall management yaw damper (SMYD) computer. No.1 SMYD computer shakes Captain’s control column, No.2 SMYD computer shakes First Officer’s control column. Vibrations can be felt on both columns

- inhibited while airborne.

Landing Gear Warning Cutout Switch



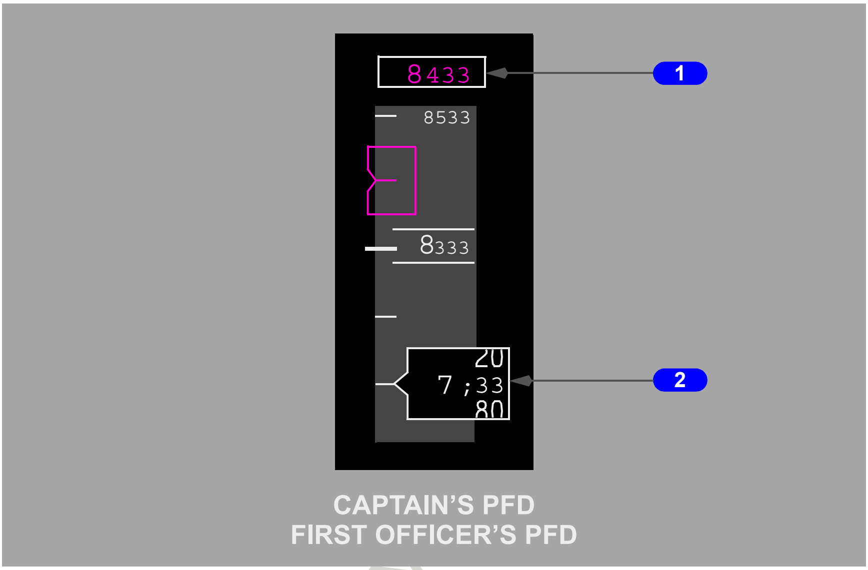
CONTROL STAND

1 Landing Gear Warning Cutout Switch

Push – silences landing gear configuration warning aural indication at flaps up through 10 and above 200 feet RA.

Note: The aural indication cannot be silenced with the cutout switch at flaps greater than 10.

Altitude Alert



1 Selected Altitude Alert

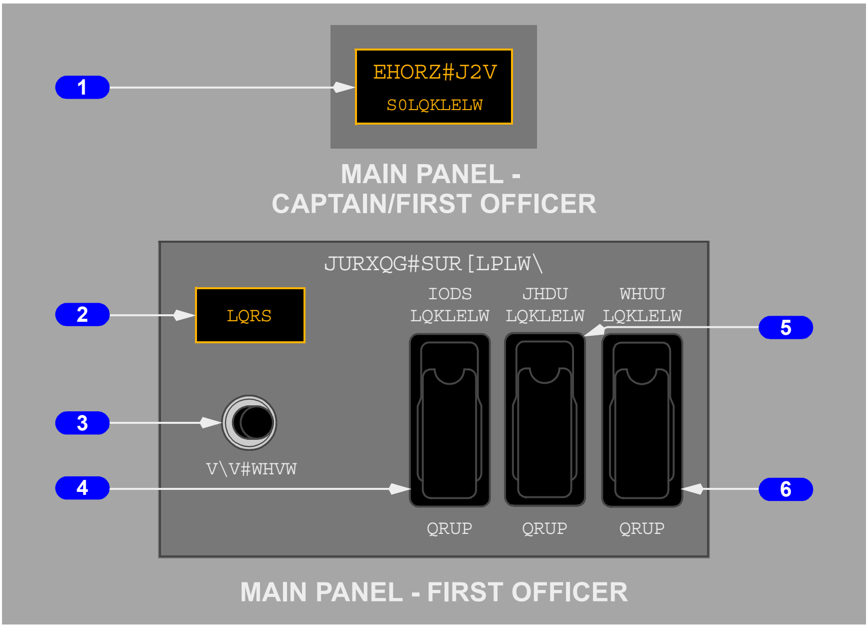
A white box shows around the selected altitude display between 900 feet and 300 feet (200 feet for -EB1 fleet) before reaching the selected altitude.

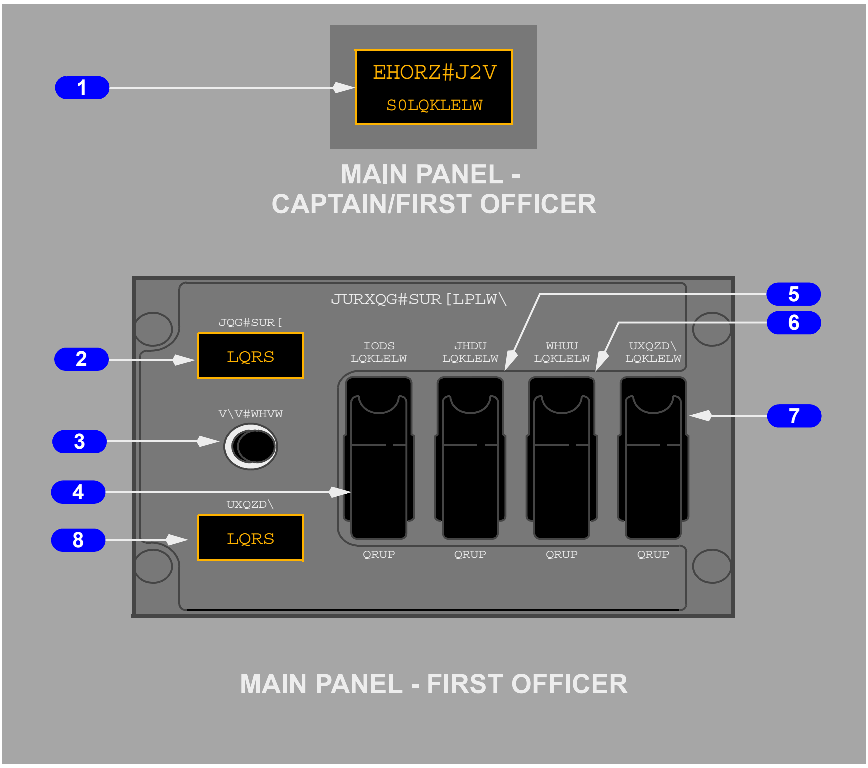
2 Current Altitude Alert

The white box around the current altitude display becomes bold between 900 feet and 300 feet (200 feet for -EB1 fleet) before reaching the selected altitude.

The box turns amber and flashes for 300 feet (200 feet for -EB1 fleet) to 900 feet deviation from the selected altitude.

Ground Proximity Warning System (GPWS)
GPWS Controls





1 BELOW Glideslope (G/S) light

The BELOW G/S light illuminates when the GPWS senses excessive deviation below the ILS or GLS glideslope or the FMC generated flight path angle.

Illuminated (amber) – below glideslope alert is active.

Push – inhibits ground proximity GLIDESLOPE alert when below 1,000 feet radio altitude.

2 Inoperative (INOP) light

Illuminated (amber) – GPWS computer malfunction or power loss

- invalid inputs are being received from radio altimeter, ADIRU, ILS receiver, IRS, FMC, stall management computers, DPC, or EFIS control panel.

Note: In the event of a DPC failure, the GND PROX INOP light will illuminate, and the EBAW/ROLL AUTHORITY aural alert will not function; however, the visual alert, if triggered, will be valid if displayed on the PFD.

3 Ground Proximity System Test (SYS TEST) Switch

Push –

- momentarily on ground:
  - •BELOW G/S and GPWS INOP lights illuminate
  - •TERR FAIL and TERR TEST show on navigation displays
  - •PULL UP and WINDSHEAR alerts illuminate
  - •GLIDESLOPE, PULL UP, and WINDSHEAR aurals sound
  - •terrain display test pattern shows on navigation displays
  - •CAUTION TERRAIN aural sounds and TERRAIN caution message shows on navigation displays.
  - •Runway Awareness and Advisory System (RAAS) selected callouts sound.
  - •AIRSPEED LOW.
- until self-test aurals begin, on ground, above indications always occur first, followed by these additional aurals, as described in section 15-20:
  - •radio altitude based alerts
  - •bank angle alert
  - •approach callouts
  - •windshear alert
  - •look ahead terrain alerts
- system test inhibited in-flight.

4 Ground Proximity FLAP INHIBIT Switch

FLAP INHIBIT – inhibits ground proximity TOO LOW FLAPS alert.

NORM (guarded position) – Normal TOO LOW FLAPS alert active.

5 Ground Proximity GEAR INHIBIT Switch

GEAR INHIBIT – inhibits ground proximity TOO LOW GEAR alert.

NORM (guarded position) – Normal TOO LOW GEAR alert active.

6 Ground Proximity Terrain Inhibit (TERR INHIBIT) Switch

TERR INHIBIT – inhibits look–ahead terrain alerts and terrain display.

NORM (guarded position) – Normal terrain alerts and terrain display active.

7 Ground Proximity Runway Inhibit (RUNWAY INHIBIT) Switch (as installed)

RUNWAY INHIBIT – inhibits RAAS callouts and alerts.

NORM (guarded position) – Normal RAAS alerts and RAAS display active.

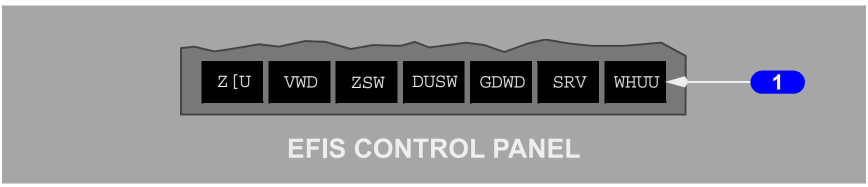
Inhibits: In-Air Overrun Warning and On-Ground Overrun Warning.

8 Runway Inoperative (INOP) Light (as installed)

Illuminated (amber) – One of the following occurs:

- RAAS failure
- GPS position accuracy is inadequate
- the airport is not in the GPWS database
- the airport is not in the RAAS runway database
- Ground Proximity Runway Inhibit Switch unreasonable: Airspeed 250 knots or greater for more than 60 seconds with Ground Proximity Runway Inhibit Switch in INHIBIT position.

GPWS Terrain Display Select Switch

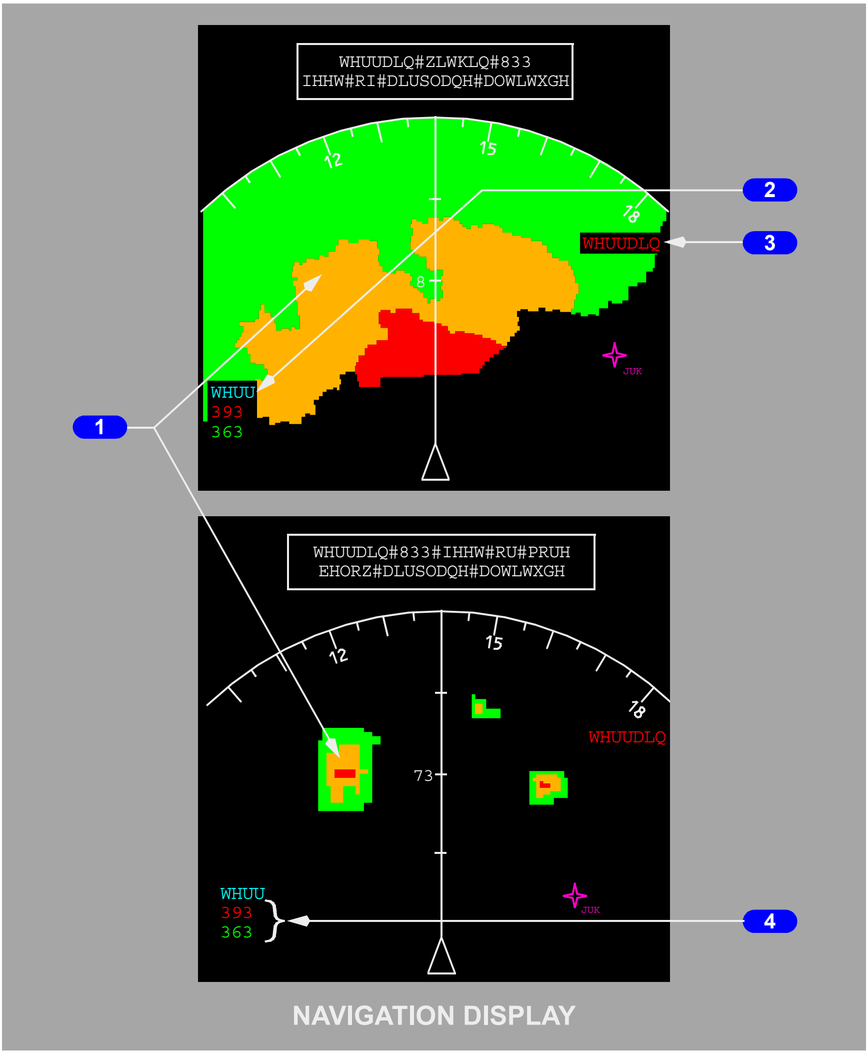


1 Terrain (TERR) Display Select Switch

Push –

- shows terrain data in expanded MAP, center MAP, expanded VOR, and expanded APP modes
- arms terrain data in PLN, center VOR, and center APP modes
- deselects weather radar display regardless of mode selector position
- second push deselects terrain display.

Terrain Display



1 Terrain Display

Graphical representation of surrounding terrain and obstacles.

When the airplane is **500 feet or more** above the highest terrain in the selected display range, terrain is depicted in green, and color density varies based on terrain elevation:

- Solid green: Highest elevation terrain
- High-density dotted green: Intermediate elevation terrain
- Low-density dotted green: Lowest elevation terrain
- Black: No significant terrain

When the airplane is **less than 500 feet** above the highest terrain in the selected display range, color and density vary based on terrain elevation vs. airplane altitude:

- Solid red: Look-ahead terrain warning active
- Solid amber: Look-ahead terrain caution active
- Dotted red: Terrain more than 2,000 feet above airplane's current altitude
- Dotted amber: Terrain 500 feet (250 feet with gear down) below to 2,000 feet above the airplane's current altitude
- Dotted green: Terrain from 2,000 feet below to 500 feet (250 feet with gear down) below the airplane's current altitude
- Black: No significant terrain
- Dotted magenta: No terrain data available

Note: In areas without terrain data, look-ahead terrain alerting and display functions are not available. Radio altitude based terrain alerts function normally.

Note: Terrain within 200 feet of the nearest airport runway elevation does not show.

Automatically shows when:

- a look-ahead terrain alert occurs, and
- neither pilot has the terrain display selected, and
- in expanded MAP, center MAP, expanded VOR, or expanded APP modes.

Updates with a display sweep, similar to weather radar display.

2 Terrain Mode Annunciation

TERR (cyan) – Terrain display enabled (manual or automatic display).

3 Look-Ahead Alert

Shows in all navigation display modes.

TERRAIN

- Red – look-ahead terrain warning alert active.
- Amber – look-ahead terrain caution alert active.

OBSTACLE

- Red – obstacle warning alert active.
- Amber – obstacle caution alert active.

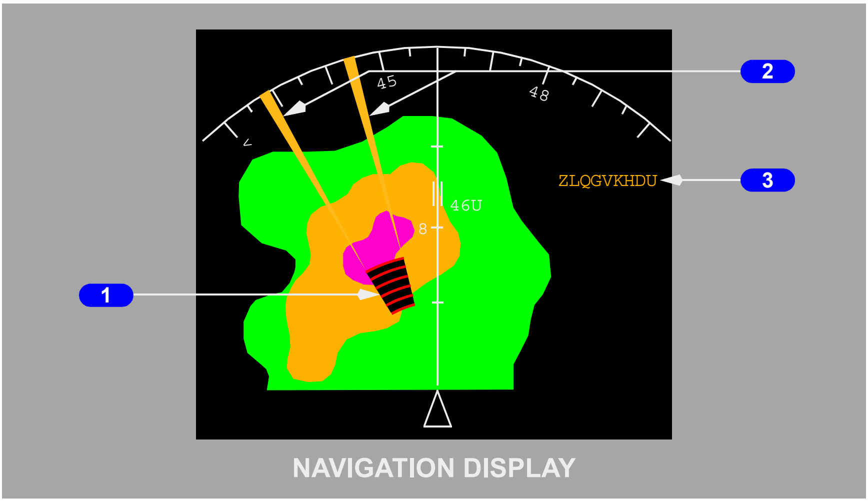
4 TERR (Terrain) Elevation Number

Displays elevation of highest and lowest terrain. The color of the elevation number corresponds to the terrain elevation:

- Green – terrain elevation is more than 500 ft below airplane altitude.
- Amber – terrain elevation is between 500 ft below and 2000 ft above airplane altitude
- Red – terrain elevation is more than 2000 ft above airplane altitude

Note: Values displayed are applicable to terrain that is generally ahead of the airplane flight path. Terrain near the left and right margins of the display may not be included in the calculations.

Predictive Windshear Display and Annunciations



1 Predictive Windshear Symbol

Displayed (red and black) – Predictive windshear alert active.

Shows windshear location and approximate geometric size (width and depth).

Symbol, radials, and weather radar returns automatically show when:

- predictive windshear alert occurs, and
- neither pilot has WXR display selected, and
- in expanded MAP, center MAP, expanded VOR, or expanded APP modes.

When terrain display is active, weather radar display replaces terrain display.

2 Predictive Windshear Symbol Radials

Displayed (amber) – Predictive windshear alert active.

Extend from predictive windshear symbol to help identify location of windshear event

3 WINDSHEAR Annunciation

WINDSHEAR (amber) – predictive windshear caution active.

WINDSHEAR (red) – predictive windshear warning active.

Shows in all navigation display modes.

TCAS Controls (Transponder Panel)

AFT ELECTRONIC PANEL

AFT ELECTRONIC PANEL

1 Transponder Mode Selector

TA (traffic advisory) – enables the display of traffic advisory (TA) targets.

TA/RA (resolution advisory) – enables the display of traffic advisory (TA) and resolution advisory (RA) targets.

1 Transponder Mode Selector

TA (traffic advisory) ONLY – enables the display of traffic advisory (TA) targets.

TA/RA (resolution advisory) – enables the display of traffic advisory (TA) and resolution advisory (RA) targets.

Warning Systems — Chapter 15
System Description — Section 20

Introduction

Aural, tactile and visual warning signals alert the flight crew to conditions requiring action or caution in the operation of the airplane. The character of the signals varies, depending upon the degree of urgency or hazards involved. Aural, tactile, and visual signals are used singularly or in combination to simultaneously provide both warnings and information regarding the nature of the condition.

Mach/airspeed warnings, landing gear warnings, takeoff configuration warnings, windshear warnings, and ground proximity warnings are discussed in this section. Cabin altitude warning is discussed in this section and in the Air Systems chapter, and autopilot and autothrottle disengage warnings are discussed in the Automatic Flight chapter. The conditions which excite the fire warning bell are discussed in the Fire Protection chapter.

Conditions which require the immediate attention of the flight crew are indicated by red warning lights located in the area of the pilots' primary field of vision. These lights indicate engine, wheel well, cargo, or APU fires; autopilot, autothrottle disengages; and landing gear unsafe conditions.

Conditions which require the timely attention of the flight crew are indicated by amber caution lights.

Blue lights inform the flight crew of electrical power availability, valve position, equipment status, and flight attendant or ground communications. Blue lights are for information and do not require immediate flight crew attention. Some system blue lights indicate a transitional state by illuminating bright as valves or components reposition, then returning to a dim blue when the required configuration is reached.

Green lights indicate a fully extended configuration, e.g., landing gear and leading edge devices.

For specific information regarding red, amber, blue, and green lights refer to the appropriate systems chapters.

Stall warning is provided by a control column shaker on each control column.

Various aural signals call attention to warnings and cautions. An aural warning for airspeed limits is given by a clacker, the autopilot disengage by a warning tone, takeoff configuration and cabin altitude by an intermittent horn, and landing gear positions by a steady horn. The fire warning by a fire warning bell. Ground proximity warnings and alerts, and windshear warnings and alerts are given by voice warnings.

Generally, aurals automatically silence when the associated non–normal condition no longer exists.

Master Fire Warning Lights

Two master FIRE WARN lights illuminate when any fire warning condition occurs. The lights remain illuminated as long as the condition exists. Pushing either master FIRE WARN light or fire warning bell cutout switch extinguishes both lights, silences the fire warning bell and resets the system for future warnings. Further information appears in the Fire Protection chapter.

Master Caution Lights

Two MASTER CAUTION lights illuminate when any caution occurs outside the normal field of vision of the flight crew. The lights remain illuminated as long as the caution condition exists, or until the crew resets the system. Pushing either MASTER CAUTION light extinguishes both lights and resets the master caution system for further cautions. Pushing either annunciator light panel recalls all existing fault annunciations.

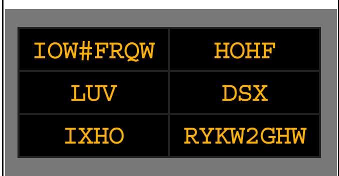
A single fault in certain redundant systems, also known as a "simple fault," does not illuminate the MASTER CAUTION and system annunciator lights. However, this type of fault is stored in the master caution system. Pushing the system annunciator recalls the simple fault on the system annunciator panel.

When the MASTER CAUTION recall is pressed, all twelve system lights should illuminate while the press-to-test feature is held. If a system annunciator light does not illuminate, refer to the Dispatch Deviation Guide (DDG).

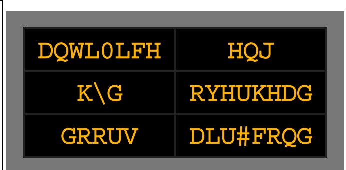
System Annunciator Lights

Two system annunciator light panels are located on the glare shield. The annunciator light panels include only those systems located on the forward overhead, aft overhead, and fire control panels. If a caution condition exists, the appropriate system annunciator(s) and MASTER CAUTION lights illuminate.

System Annunciators and Related Amber Lights – Left Side

FLT CONT		ELEC
LOW QUANTITY		DRIVE
LOW PRESSURE		STANDBY PWR OFF
FEEL DIFF PRESS		TRANSFER BUS OFF
SPEED TRIM FAIL		SOURCE OFF
MACH TRIM FAIL		TR UNIT
AUTO SLAT FAIL		BAT DISCHARGE
YAW DAMPER		ELEC
ASSIST ON		
STBY RUD ON		
SPOILERS		
IRS	LEFT SIDE GLARESHIELD	**APU**
FAULT		LOW OIL PRESSURE
ON DC		FAULT
DC FAIL		OVERSPEED
GPS		DOOR
ILS		
GLS		
FUEL		**OVHT/DET**
LOW PRESSURE		ENGINE 1 OVERHEAT
FILTER BYPASS		ENGINE 2 OVERHEAT
		APU DET INOP

System Annunciators and Related Amber Lights – Right Side

ANTI–ICE		ENG
WINDOW OVERHEAT PROBE HEAT ENG ANTI-ICE COWL ANTI–ICE COWL VALVE WING L/R VALVE		REVERSER LIMITED EEC ALTN MODE ENGINE CONTROL REVERSER COMMAND REVERSER AIR/GND
HYD		OVERHEAD
OVERHEAT LOW PRESSURE	 RIGHT SIDE GLARESHIELD	EQUIP COOLING–OFF EMER EXIT LIGHTS–NOT ARMED FLIGHT RECORDER–OFF PASS OXY–ON MAINT EQUIP SMOKE ELT
DOORS		AIR COND
EQUIP FWD/AFT ENTRY FWD/AFT SERVICE LEFT/RIGHT FWD(AFT) OVERWING FWD/AFT CARGO		ZONE TEMP DUAL BLEED PACK WING–BODY OVERHEAT BLEED AUTO FAIL OFF SCHED DESCENT

Warning Systems
Intermittent Cabin Altitude/Configuration Warning

Takeoff configuration warning is armed when the airplane is on the ground and either or both forward thrust levers are advanced for takeoff. Takeoff configuration warning activates if:

- trailing edge flaps are not in the flaps 1 through 25 takeoff range, or
- trailing edge flaps are in a skew or asymmetry condition, or have uncommanded motion, or
- leading edge devices are not configured for takeoff or have uncommanded motion, or
- speed brake lever is not in the DOWN position, or
- spoiler control valve is open providing pressurized hydraulic fluid to the ground spoiler interlock valve, or
- parking brake is set, or
- mid exit door not secure, or
- overwing door not secure, or
- stabilizer trim not set in the takeoff range.

An intermittent warning horn sounds and the TAKEOFF CONFIG warning light illuminates when takeoff configuration warning activates.

Cabin altitude warning activates when cabin altitude exceeds 10,000 feet. An intermittent warning horn sounds and the CABIN ALTITUDE warning light illuminates. The warning horn may be silenced by momentarily pressing the ALT HORN CUTOUT switch on the Cabin Altitude Panel. The warning light remains illuminated until the cabin altitude descends below 10,000 feet.

WARNING: The Cabin Altitude and Takeoff Configuration Warnings use the same intermittent tone when activated.

Landing Gear Configuration Warnings

Visual indications and aural warnings of landing gear position are provided by the landing gear indicator lights and landing gear warning horn.

Visual Indications

The landing gear indication lights are activated by signals from each gear, the LANDING GEAR lever, and the forward thrust lever position as follows:

Green light illuminated – landing gear is down and locked.

Red light illuminated –

- landing gear is in disagreement with LANDING GEAR lever position (in transit or unsafe).
- landing gear is not down and locked (with either or both forward thrust levers retarded to idle, and below 800 feet AGL).

All lights extinguished – landing gear is up and locked with the LANDING GEAR lever UP.

Aural Indications

A steady warning horn is provided to alert the flight crew whenever a landing is attempted and any gear is not down and locked. The landing gear warning horn is activated by forward thrust lever and flap position as follows:

Flaps up through 10 –

- altitude below 800 feet RA, when either forward thrust lever set between idle and approximately 20 degrees thrust lever angle, or an engine is not operating and the other thrust lever is less than 34 degrees. The landing gear warning horn can be silenced (reset) with the landing gear warning HORN CUTOUT switch
- if the airplane descends below 200 feet RA, the warning horn cannot be silenced by the warning HORN CUTOUT switch.

Flaps 15 through 25 –

- either forward thrust lever set below approximately 20 degrees, or an engine not operating and the other thrust lever is less than 34 degrees. The landing gear warning horn cannot be silenced with the landing gear warning HORN CUTOUT switch.

Flaps greater than 25 –

- regardless of forward thrust lever position. The landing gear warning horn cannot be silenced with the landing gear warning HORN CUTOUT switch.

The warning indication is canceled when the configuration error is corrected.

Mach/Airspeed Warning System

Two independent Mach/airspeed warning systems provide a distinct aural warning, a clacker, any time the maximum operating airspeed of Vmo/Mmo is exceeded. The warning clackers can be silenced only by reducing airspeed below Vmo/Mmo.

The airspeed indicator displays red and black warning bands indicating maximum and minimum allowable airspeeds. The ends of the amber bands indicate maximum and minimum maneuver speeds.

When either an overspeed condition or a system test occurs, the ADIRU transmits a signal to the aural warning module, sounding the clacker. The system can only be tested on the ground.

Stall Warning System

Natural stall warning (buffet) usually occurs at a speed prior to stall. In some configurations the margin between stall and natural stall warning is less than desired. Therefore, an artificial stall warning device, a stick shaker, is used to provide the required warning.

The stall warning “stick shaker” consists of two eccentric weight motors, one on each control column. They are designed to alert the pilots before a stall develops. The warning is given by vibrating both control columns. The system is armed in flight at all times. The system is deactivated on the ground.

Two independent, identical stall management yaw damper (SMYD) computers determine when stall warning is required based upon:

- alpha vane angle of attack outputs
- ADIRU outputs
- anti–ice controls
- wing configurations
- air/ground sensing
- thrust
- FMC outputs.

The SMYD computers provide outputs for all stall warning to include stick shaker and signals to the pitch limit indicator and airspeed displays and the GPWS windshear detection and alert.

Two test switches are installed in the aft overhead panel. Pushing either of these initiates a self–test of the respective stall warning channel. The No.1 activates the Captain stick shaker, and the No. 2 activates the F/O stick shaker. Either stick shaker vibrates both columns through column interconnects.

Autoland Advisory Messages

(as installed)

When a system failure is detected that affects autoland status, an advisory message is displayed on the engine display. Two advisories, NO LAND 3 and NO AUTOLAND, are available. Only one advisory message can be displayed at one time. A cancel/recall switch, located on the MFD panel, controls the display and recall of the advisory messages.

The NO LAND 3 advisory will be annunciated when a failure has occurred above Alert Height and the system is still capable of continuing to a safe landing. With this advisory, LAND 2 will be the resulting autoland status annunciation displayed following dual autopilot engagement on approach.

The NO AUTOLAND advisory is displayed any time above the Alert Height to notify the crew a failure has occurred and the system is unable to perform an automatic landing.

Maintenance Alert

When designated faults are detected, a MAINT light on the aft overhead panel illuminates, and the OVERHEAD system annunciator light and MASTER CAUTION lights illuminate.

The MAINT light is inhibited:

- in flight
- after engine start switch is placed to GRD during the first engine start
- for 30 seconds after landing.

Altitude Alerting System

Altitude alerting occurs when approaching or departing the MCP–selected altitude. Altitude alerting is inhibited when trailing edge flaps are extended to 25 or greater, or while G/S is captured.

Alerts

Acquisition Alerting

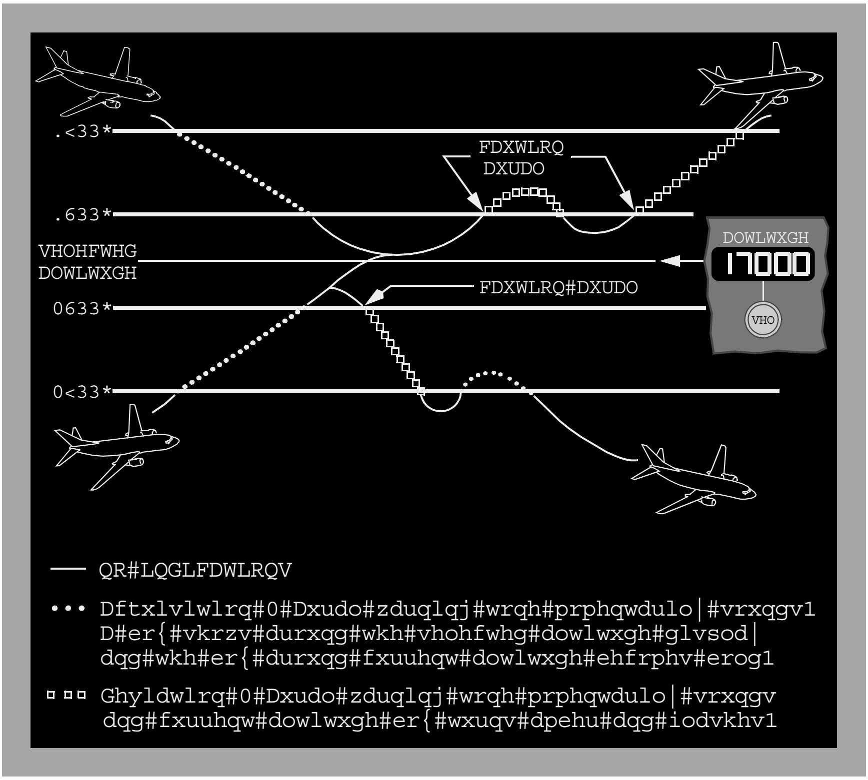
900 feet before reaching the selected altitude, a white box shows around the selected altitude display and the box around the current altitude becomes bold. A momentary tone sounds. At 300 feet from selected altitude, the selected altitude box no longer shows.

Deviation Alerting

When deviating by 300 feet from the selected altitude, a momentary tone sounds and the current altitude box turns amber and begins to flash. The amber flashing continues until:

- altitude deviation becomes less than 300 feet
- altitude deviation becomes more than 900 feet
- a new altitude is selected.

Altitude Alert Profile



Ground Proximity Alerts

The GPWS provides alerts for potentially hazardous flight conditions involving imminent impact with the ground.

The GPWS provides alerts based on radio altitude and combinations of barometric altitude, airspeed, glideslope deviation, airplane configuration and airplane attitude. The alerts are for:

- excessive descent rate
- excessive terrain closure rate
- altitude loss after takeoff or go-around
- unsafe terrain clearance when not in the landing configuration
- excessive deviation below an ILS glideslope
- excessive deviation below glide path
- altitude callouts
- reactive windshear

These alerts are “radio altitude based alerts.” The GPWS does not alert the flight crew toward vertically sheer terrain or slow descent into unprepared terrain while in the landing configuration.

The GPWS also monitors terrain proximity using an internal world wide terrain data base. Proximate terrain data shows on the navigation display. If there is a potential terrain conflict, alerts are provided based on estimated time to impact. These alerts are “look-ahead terrain alerts.”

Ground proximity alerts are accompanied by voice aural alerts and the PULL UP annunciation on the attitude indicators or, for deviation below glideslope alert, the BELOW G/S light.

Note: Terrain ahead of the airplane may exceed available climb performance. A ground proximity alert does not guarantee terrain clearance.

Look-ahead terrain alerts and radio altitude based alerts are prioritized based on the level of hazard and the required flight crew reaction time. Look-ahead terrain alerts and radio altitude based alerts are inhibited by an actual windshear warning (airplane in windshear).

Look–Ahead Terrain Alerting

The GPWS terrain data base contains detailed terrain data near major airports, and data in lesser detail for areas between airports. Terrain within 2,000 feet of airplane barometric altitude shows on the navigation display. The terrain data is not designed to be an independent navigation aid.

The terrain display is generated from a data base contained in the GPWS computer and correlated to GPS position.

Terrain and weather radar cannot show together on a display. If one pilot selects terrain and the other pilot selects weather radar, each display updates on alternating sweeps. All other displays (TCAS, LNAV routing, etc.) can show with terrain data.

Look-ahead terrain alerts are based on the airplane’s position, barometric altitude, vertical flight path, and ground speed.

Look Ahead Terrain Alerts

AURAL ALERT	VISUAL ALERT	DESCRIPTION
TERRAIN TERRAIN, PULL UP	PULL UP on both attitude indicators Red TERRAIN message on navigation display (all modes) Solid red terrain on navigation display	20 to 30 seconds from projected impact with terrain shown solid red on the navigation display (in expanded MAP, center MAP, expanded VOR, or expanded APP modes only). Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.
CAUTION TERRAIN	Amber TERRAIN message on navigation display (all modes) Solid amber terrain on navigation displays	40 to 60 seconds from projected impact with terrain shown solid amber on the navigation display (in expanded MAP, center MAP, expanded VOR, or expanded APP modes only). Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.
TOO LOW, TERRAIN	PULL UP on both attitude indicators	Descent below unsafe radio altitude while too far from any airport in the terrain database. Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.

Radio Altitude Based Alerts

AURAL ALERT	VISUAL ALERT	DESCRIPTION
PULL UP	PULL UP on both attitude indicators	Follows SINK RATE alert if excessive descent rate continues or increases. Follows radio altitude based TERRAIN alert if excessive terrain closure rate continues and landing gear and/or flaps are not in landing configuration.
TERRAIN	PULL UP on both attitude indicators	Excessive terrain closure rate.
DON’T SINK	PULL UP on both attitude indicators	Excessive altitude loss after takeoff or go–around.
GLIDESLOPE	BELOW G/S P–INHIBIT lights	Deviation below glideslope. Volume and repetition rate increase as deviation increases. Pushing the ground proximity BELOW G/S P-INHIBIT light cancels or inhibits the alert below 1,000 feet RA.
SINK RATE	PULL UP on both attitude indicators	Excessive descent rate.
TOO LOW, FLAPS	PULL UP on both attitude indicators	Unsafe terrain clearance at low airspeed with flaps not in a normal landing position. Pushing the ground proximity flap inhibit switch to FLAP INHIBIT inhibits the alert.
TOO LOW, GEAR	PULL UP on both attitude indicators	Unsafe terrain clearance at low airspeed with landing gear not down. Pushing the ground proximity gear inhibit switch to GEAR INHIBIT inhibits the alert.

AURAL ALERT	VISUAL ALERT	DESCRIPTION
TOO LOW, TERRAIN	PULL UP on both attitude indicators	Unsafe terrain clearance at high airspeed with either landing gear not down or flaps not in landing position. Follows DON'T SINK if another descent is initiated after initial alert, before climbing to the altitude where the initial descent began.

Obstacle Alerts

Obstacle display and alerting provides caution and warning level alerts for man-made obstacles 100 feet and higher.

Aural Alert	Visual Alert	Description
OBSTACLE OBSTACLE, PULL UP	PULL UP on both attitude indicators Red OBSTACLE message on ND (all modes) Solid red terrain on ND	20 to 30 seconds from projected impact with obstacle shown solid red on the ND (in MAP, MAP CTR, VOR, or APP modes only). Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.
CAUTION OBSTACLE	Amber OBSTACLE message on ND (all modes) Solid amber terrain on ND	40 to 60 seconds from projected impact with obstacle shown solid amber on the ND (in MAP, MAP CTR, VOR, or APP modes only). Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.

Runway Awareness and Advisory System (RAAS)

(as installed)

System Overview

The Runway Awareness and Advisory System (RAAS) is an enhancement to the GPWS system. RAAS provides aural callouts along with visual alerts on the Navigation Display (ND) to assist the flight crew with situational awareness during ground operations, approach to landing, and go-around.

RAAS requires the following databases or systems for proper operation:

- terrain and airport runway database is in the GPWS computer,
- airplane is on or approaching an airport in the RAAS airport runway database,
- global positioning system (GPS) and other required signals are available and accuracy meets minimum requirements.

When enabled, RAAS operates without any action required from the flight crew. If desired, RAAS availability can be verified on the ground. There is no automatic display of RAAS functionality.

RAAS callouts and alerts may be inhibited by the Runway Inhibit switch. To alert the crew, the RUNWAY INOP Light will illuminate if the Runway Inhibit switch is in the "INHIBIT" position and the airspeed has been 250 knots or greater for at least 60 seconds.

Callouts, Alerts and ND Messages During Taxi and Takeoff on RAAS Airports

Callouts, Alerts and ND Messages	Description
Callout: CAUTION ON TAXIWAY, ON TAXIWAY ND amber message: ON TAXIWAY	Sounds once each time the airplane: • is on a surface other than a runway, and • ground speed is greater than 40 knots
APPROACHING (RUNWAY IDENTIFIER of runway end closest to airplane position)	Sounds once each time the airplane: • approaches a runway, and • ground speed is less than 40 knots
APPROACHING RUNWAYS	Sounds once each time the airplane: • approaches two runways within 20 degrees of each other, and • ground speed is less than 40 knots
ON RUNWAY (RUNWAY IDENTIFIER)	Sounds once when the airplane:: • enters a runway, and • heading is within 20 degrees of the runway heading

Callouts, Alerts and ND Messages	Description
ON RUNWAY (RUNWAY IDENTIFIER)	Sounds when the airplane: • remains on the runway, and • moves less than 100 feet after entering runway, and • heading is within 20 degrees of the runway heading

Callout, Alerts and ND Messages During Approach, Landing, Go-Around, and RTO on RAAS Airports

<table>
<tr><th>Voice Callouts, Alerts and ND Messages</th><th>Description</th></tr>
<tr><td>APPROACHING (RUNWAY IDENTIFIER)</td><td>Sounds once each time the airplane:
• approaches within three nautical miles of a runway threshold, and
• is within 20 degrees of the runway heading, and
• is within approximately 200 feet plus one runway width of the runway extended center line, and
• is between 750 feet and 300 feet field elevation.
The callout is inhibited between 550 and 450 feet above field elevation. When the airplane descends below 450 feet, the callout will be annunciated.</td></tr>
<tr><td>APPROACHING RUNWAYS</td><td>Sounds once each time the description is met while approaching two runways.</td></tr>
<tr><td rowspan="2">(FEET) REMAINING</td><td>Sounds during RTO when the airplane is on the ground:
• is on a defined minimum length from the runway end
• with ground speed greater than 40 knots, and
• after ground speed decreases by seven knots from the maximum ground speed achieved</td></tr>
<tr><td>Sounds once each time the airplane is:
• over a defined minimum length from the runway end, and:
•during rollout with airspeed less than 40 knots, or
•during go-around when less than 100 feet above the ground
During go-around after the callout REMAINING sounds, the callouts continue to sound until the airplane is:
• higher than 100 feet above the runway, or
• rate of climb is greater than 450 feet per minute</td></tr>
</table>

Voice Callouts, Alerts and ND Messages	Description
ONE HUNDRED REMAINING	Sounds once each time the airplane: • is within 20 degrees of the runway heading, and • is within 100 feet of the end of a runway, and • ground speed is less than 40 knots

Assumptions, Limitations and Constraints

Defined nominal runway length for landing and advisory hold times are options specified by an operator.

In flight callouts and alerts are based on an algorithm that numerically subtracts the landing runway touchdown zone elevation in the GPWS database from the pressure altitude of the airplane. The term "above field elevation" is used in the system description for these altitudes.

Note:

- RAAS callouts and alerts are based on RAAS airport runway database details and GPS position
- RAAS does not include knowledge of ATC clearances or flight crew intent
- RAAS does not take into account airplane performance factors such as airplane weight, wind, runway conditions, slope, air temperature, or airport altitude
- absence of a RAAS annunciation does not ensure that the that a runway is appropriate for takeoff or landing
- RAAS annunciations do not ensure that a runway can, or cannot, be safely used for takeoff or landing
- The Flight Crew is responsible by other means to ensure correct runway selection. RAAS does not include knowledge of Notice to Airmen (NOTAM) or Automatic Terminal Information Service (ATIS)
- RAAS callouts and alerts are not intended for navigation purposes
- RAAS is not designed to enhance traffic awareness.

RAAS callouts and alerts have a lower priority than any GPWS alert, including Radio Altitude callouts. Some may reoccur, depending on airplane position, when the higher priority advisory clears.

In-Air Overrun Warning

(as installed)

The In-Air Overrun Warning alerts the flight crew that an overrun is likely to occur if the approach and landing is continued, based upon the airplane's energy state, the pilot-entered runway condition, and the remaining available landing distance. The alert is armed from 500 feet above the runway touchdown zone elevation (TDZE) until airplane touchdown.

The alert consists of a GO AROUND visual alert shown on the Primary Flight Display (PFD), and an "OVERRUN, GO AROUND" aural alert. The aural alert will repeat under the following conditions:

- Height above the TDZE is 150 feet or less, and
- the alert condition has been true for at least seven seconds.

The Enhanced Ground Proximity Warning System (EGPWS) continually computes a predicted landing distance. The in-air overrun alert activates when the predicted landing distance exceeds the distance to the end of the runway. The distance to the end of the runway is based on the EGPWS runway database and the airplane’s position.

The in-air overrun alert is inhibited when any of the following conditions are true:

- Height above TDZE is greater than 500 feet;
- the air/ground signal indicates the airplane is on the ground;
- at altitudes greater than 50 feet above TDZE, the descent rate decreases to less than 300 feet per minute for at least two seconds (the airplane is no longer descending on the approach);
- a landing runway has not been identified by the EGPWS;
- the airplane’s position accuracy is insufficient;
- the Runway Inhibit switch on the GPWS control panel is in the INHIBIT position;
- left or right thrust lever is set to at least go-around thrust (a go-around has been initiated);
- left or right thrust lever is set to idle position, and left or right reverse thrust lever is approaching the reverse idle detent (the thrust reversers are about to be deployed);
- the flaps are not set to 15, 30 or 40 degrees (flaps are not set for landing);
- the radio altitude is less than 0 feet.

On-Ground Overrun Warning

(as installed)

The On-Ground Overrun Warning alerts the alert crew that they must immediately apply maximum manual braking and maximum reverse thrust consistent with conditions, to stop the airplane by the end of the runway. The alert is armed from three seconds after touchdown until the airplane slows below 20 knots ground speed, or comes within 1000 feet of the runway end.

The alert consists of a MAX REVERSE visual alert shown on the Primary Flight Display (PFD), and a "MAX BRAKES, MAX REVERSE" aural alert. The MAX REVERSE visual alert is removed when the airplane slows below 20 knots groundspeed. The aural alert will only sound once.

The Enhanced Ground Proximity Warning System (EGPWS) continually computes a maximum effort stopping distance. The on-ground overrun alert activates when the maximum effort stopping distance exceeds the distance to the end of the runway. The distance to the end of the runway is based on the EGPWS runway database and the airplane’s position.

The on-ground overrun alert is inhibited when any of the following conditions are true:

- Airplane heading differs from the runway heading by more than 20 degrees;
- the air/ground signal indicates the airplane is in the air;
- the ground speed is less than 20 knots;
- the distance remaining to the end of the runway is less than 1000 feet;
- the airplane’s position accuracy is insufficient;
- the Runway Inhibit switch on the GPWS control panel is in the INHIBIT position;
- left or right thrust lever is above the idle position (the airplane is conducting an initial takeoff, or a go-around will be initiated);
- the flap setting is not 15, 30 or 40 degrees (the flaps are not set in a landing configuration);
- the radio altitude is 10 feet or greater.

SPEEDBRAKE Warning

(as installed)

The speedbrake alert provides a time-critical warning when speedbrakes are not deployed during a landing or rejected takeoff above 80 knots.

The alert consists of a SPEEDBRAKE visual alert shown on the Primary Flight Display (PFD), and a "SPEEDBRAKE, SPEEDBRAKE" aural alert. The aural alert does not repeat.

The Enhanced Ground Proximity Warning System (EGPWS) monitors the position of spoiler panels 4 and 9. The speedbrake alert activates if these spoiler panels are less than halfway up three seconds after touchdown or after the initiation of a rejected takeoff above 80 knots.

The speedbrake alert is inhibited if Hydraulic System A has low pressure (spoiler panels 4 and 9 are powered by Hydraulic System A).

Windshear Alerts

Windshear alerts are available during takeoff, approach, and landing:

- The GPWS provides a warning when the airplane is in a windshear.
- The weather radar provides alerts for excessive windshear ahead of the airplane. These are "predictive windshear alerts."

Windshear warnings are accompanied by a red WINDSHEAR message on the attitude indicators and voice aural alerts.

Windshear cautions are accompanied by a voice aural alert.

Windshear alerts are prioritized based on the level of hazard and the required flight crew reaction time. Predictive windshear alerts are inhibited by an actual windshear warning (airplane in windshear), look-ahead terrain alerts, or radio altitude based alerts.

Windshear Warning (Airplane in Windshear)

AURAL ALERT	VISUAL ALERT	DESCRIPTION
Two–tone siren followed by WINDSHEAR, WINDSHEAR, WINDSHEAR	Red WINDSHEAR on both attitude indicators.	Excessive windshear at the current airplane position detected by GPWS. Enabled below 1,500 feet RA. GPWS Windshear detection begins at rotation.

Predictive Windshear Alerts

The weather radar uses radar imaging to detect disturbed air prior to entering a windshear.

Note: The weather radar provides windshear alerts for windshear events containing some level of moisture or particulate matter.

Note: The weather radar detects microbursts and other windshears with similar characteristics. The weather radar does not provide alerting for all types of windshear. The flight crew must continue to rely on traditional windshear avoidance methods.

AURAL ALERT	VISUAL ALERT	DESCRIPTION
WINDSHEAR AHEAD	Red WINDSHEAR on both attitude indicators RED windshear symbol on navigation display Red WINDSHEAR message on navigation display (all modes)	Windshear close to and directly ahead of the airplane detected by the weather radar. Enabled during takeoff, below 1,200 feet RA. Predictive windshear symbol on the navigation display shows windshear position (expanded MAP, center MAP, expanded VOR or expanded APP modes only).
GO AROUND, WINDSHEAR AHEAD	Red WINDSHEAR on both attitude indicators RED windshear symbol on navigation display Red WINDSHEAR message on navigation display (all modes)	Windshear within 1.5 miles and directly ahead of the airplane detected by the weather radar. Enabled during approach, below 1,200 feet RA. Predictive windshear symbol on the navigation display shows windshear position (expanded MAP, center MAP, expanded VOR or expanded APP modes only).
MONITOR RADAR DISPLAY	RED windshear symbol on navigation display Amber WINDSHEAR message on navigation display (all modes)	Windshear within 3 miles and ahead of the airplane detected by the weather radar. Enabled during takeoff and approach, below 1,200 feet RA. Predictive windshear symbol on the navigation display shows windshear position (expanded MAP, center MAP, expanded VOR or expanded APP modes only).

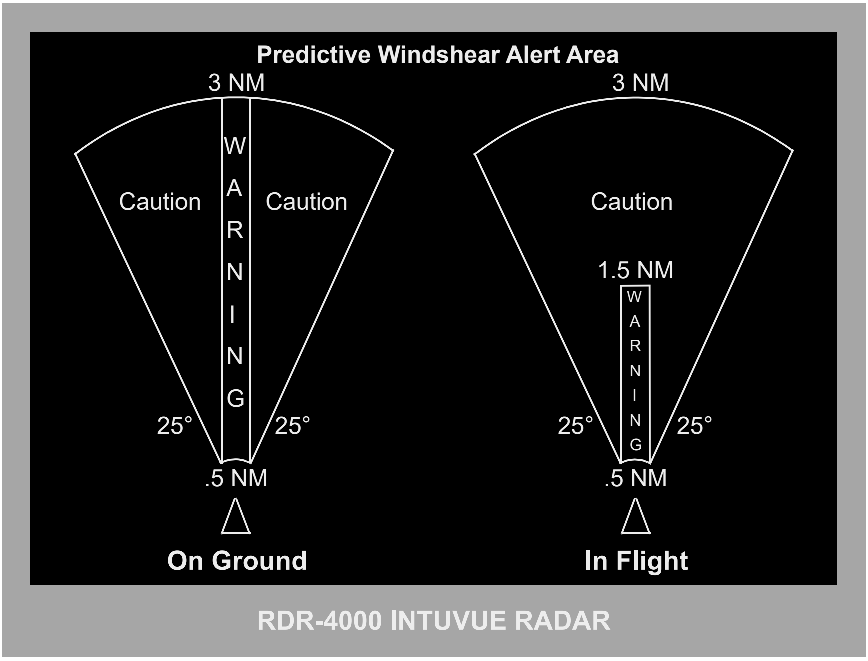
The weather radar automatically begins scanning for windshear when:

- thrust levers set for takeoff, even if engine is off or IRS not aligned, or
- in flight below 2,300 feet RA (predictive windshear alerts are issued below 1,800 feet RA).

Alerts are available approximately 12 seconds after the weather radar begins scanning for windshear. The Predictive Windshear System (PWS) detects the presence of windshear ahead of the aircraft, giving 10 to 60 seconds of warning before the encounter. The windshear mode will automatically be turned on under the following conditions:

- inflight, below 1,800 feet AGL
- on the ground, engine at takeoff thrust setting

If windshear is not detected, weather radar returns show only after pushing the EFIS control panel WXR switch.



Predictive Windshear Inhibits

During takeoff and landing, new predictive windshear caution alerts are inhibited between 80 knots and 400 feet RA, and new warning alerts between 100 knots and 50 feet RA. These inhibits do not remove existing predictive windshear alerts. If a warning/caution event occurs before those boundaries, it will remain on the display and the complete aural callout will be annunciated.

Bank Angle Alert

The GPWS provides the aural alert BANK ANGLE, BANK ANGLE when there is excessive roll of the airplane. Once sounded, the alert is silent for that bank angle until the system is reset by decreasing the bank angle to 30 degrees or less. The alert is based on radio altitude and bank angle:

- from 5 feet to 30 feet AGL, the alert sounds when the bank angle exceeds 10 degrees
- from 30 feet to 130 feet AGL, when the alert sounds varies linearly from a bank angle of 10 degrees at 30 feet AGL, to a bank angle of 35 degrees at 130 feet AGL
- above 130 feet AGL, the alert sounds when the bank angle exceeds 35, 40 or 45 degrees.

Bank Angle Alerts

AURAL ALERT	VISUAL ALERT	DESCRIPTION
BANK ANGLE, BANK ANGLE	None	Bank angle exceeds 10 degrees when airplane is between 5 and 30 feet AGL or Variable activation when bank angle exceeds a value between 10 degrees and 35 degrees, when airplane is between 30 feet AGL and 130 feet AGL or Bank angle exceeds 35 degrees when airplane is above 130 feet AGL.

Roll/Yaw Asymmetry Alert

When the autopilot has reached 75% of its total roll authority:

- An amber alert, ROLL/YAW ASYMMETRY appears on the Primary Flight Display (PFD);
- the bank pointer and slip/skid indicator become outlined in amber;
- if the slip/skid indicator is deflected greater than 25% of its width, the slip/skid indicator becomes solid amber.

Roll Authority Alert

When the autopilot has reached 100% of its total roll authority:

- The amber alert, ROLL AUTHORITY appears on the PFD;
- The aural alert, "ROLL AUTHORITY, ROLL AUTHORITY," annunciates;
- the bank pointer and slip/skid indicator become outlined in amber;
- if the bank angle exceeds 15 degrees, the bank pointer becomes solid amber;
- if the slip/skid indicator is deflected greater than 25% of its width, the slip/skid indicator becomes solid amber.

Enhanced Bank Angle Warning

The Enhanced Bank Angle Warning provides a time-critical warning in case of a roll upset greater than 45 degrees of bank. The alert consists of a curved red arrow on the PFD as well as a GPWS derived aural alert. The roll command arrow and voice aural alerts indicate the shortest direction to return the airplane to wings level. If the airplane is banked beyond 45 degrees to the right or left, the arrow appears pointing to the left or right, and the aural repeats "ROLL LEFT(RIGHT)...ROLL LEFT(RIGHT)." The voice aural repeats at intervals of 5 seconds. The alert stops when the bank angle decreases below 35 degrees for at least 2 seconds, or immediately when the bank angle decreases to less than 10 degrees.

There are a number of inputs and inhibited conditions for the Enhanced Bank Angle Warning:

- At pitch angles less than 25 degrees nose up, the ROLL LEFT (RIGHT) warning triggers at 45 degrees of bank, replacing the standard 45 degree BANK ANGLE alert.
- When pitch attitude exceeds 25 degrees nose up, the ROLL LEFT(RIGHT) warning alert is suppressed until 65 degrees of bank. This feature is called the Pitch Attitude Latch.
- The Pitch Attitude Latch is deactivated when the pitch attitude exceeds 25 degrees nose up and bank angle is less than 60 degrees, or the pitch attitude decreases below 10 degrees nose up.
- When the warning is displayed, the flight director is removed from the display.
- When the warning is displayed, TCAS resolution advisories will not appear on the display.
- If stick shaker is activated, the Enhanced Bank Angle Warning is suppressed.
- If the roll attitude comparator detects a difference between IRS inputs, the Enhanced Bank Angle Warning is inhibited.

The roll command arrow points in the shortest direction to wings level. If the bank angle passes 180 degrees, the roll command arrow points in the new shortest direction to wings level.

The roll command arrow is removed when the bank angle is less than 35 degrees for two seconds, allowing the flight crew to return to a 30 degree bank, if desired. If the crew continues to roll quickly towards wings level, the roll command arrow is removed immediately at 10 degrees of bank, in order to prevent overbanking in the other direction.

Alerts and Messages

Alert	Description
ROLL/YAW ASYMMETRY on PFD. Amber outline around bank pointer. Amber outline around slip/skid indicator	Slow-onset roll condition. The autopilot has reached 75% of its total roll authority.
ROLL/YAW ASYMMETRY on PFD. Amber outline around bank pointer. Solid amber slip/skid indicator	Slow-onset roll condition. The autopilot has reached 75% of its total roll authority. Excessive yaw (slip/skid indicator deflected greater than 25% of its width).

ROLL AUTHORITY on PFD. Amber outline around bank pointer. Amber outline around slip/skid indicator. "ROLL AUTHORITY, ROLL AUTHORITY" aural.	Fast-onset roll condition. The autopilot has reached 100% of its total roll authority.
ROLL AUTHORITY on PFD. Amber outline around bank pointer. Solid amber slip/skid indicator. "ROLL AUTHORITY, ROLL AUTHORITY" aural.	Fast-onset roll condition. The autopilot has reached 100% of its total roll authority. Excessive yaw (slip/skid indicator deflected greater than 25% of its width).

ROLL AUTHORITY on PFD. Solid amber bank pointer. Amber outline around slip/skid indicator. "ROLL AUTHORITY, ROLL AUTHORITY" aural.	Fast-onset roll condition. The autopilot has reached 100% of its total roll authority. Excessive uncommanded bank (greater than 15 degrees of bank).
ROLL AUTHORITY on PFD. Solid amber bank pointer. Solid amber slip/skid indicator. "ROLL AUTHORITY, ROLL AUTHORITY" aural.	Fast-onset roll condition. The autopilot has reached 100% of its total roll authority. Excessive uncommanded bank (greater than 15 degrees of bank). Excessive yaw (slip/skid indicator deflected greater than 25% of its width).

Red roll command arrow. Solid red bank pointer. Solid red slip/skid indicator. "ROLL RIGHT, ROLL RIGHT ("ROLL LEFT, ROLL LEFT") aural.	Pitch angle less than 25 degrees, airplane has reached 45 degrees of bank angle. Pitch angle greater than 25 degree, airplane has reached 60 degrees of bank angle.

Airspeed Low Alert

An alert "AIRSPEED LOW, AIRSPEED LOW" provides the flight crew with low airspeed awareness. The aural annunciates when the current airspeed decreases into the minimum maneuver speed amber bar.

The aural coincides with the low airspeed alert on the airspeed indication.

IAN Autopilot Alert

Both visual and aural alerts are provided if the autopilot is engaged below 100 feet RA with either FAC or G/P engaged. AUTOPILOT, AUTOPILOT is announced over the cabin speaker, and an amber AUTOPILOT flashes over the attitude display.

Approach Callouts
Radio Altitude Callouts

The GPWS provides the following altitude callouts during approach:

- 2,500 feet – TWENTY FIVE HUNDRED
- 1,000 feet – ONE THOUSAND
- 500 feet – FIVE HUNDRED
- 400 feet – FOUR HUNDRED
- 300 feet – THREE HUNDRED
- 200 feet – TWO HUNDRED
- 100 feet – ONE HUNDRED
- 50 feet – FIFTY

- 40 feet – FORTY
- 30 feet – THIRTY
- 20 feet – TWENTY
- 10 feet – TEN.

Smart 500 Radio Altitude Callout

(as installed)

The Smart 500 Callout annunciates FIVE HUNDRED only when an approach has not been selected in the FMC or if there is an excessive flight path deviation, regardless of which type of approach is being flown. Activation of this callout is dependent on the lack of a glideslope or glidepath. Selecting any type of approach in the FMC will generate a glidepath and the Smart 500 callout is inhibited. The exception is if there is an excessive flight path deviation, the GPWS will provide the Smart 500 callout. With the exception of the 500 foot radio altitude callout, this feature functions with or without any of the normal altitude callouts.

When descending below 500 feet radio altitude on approach, a FIVE HUNDRED callout is given if:

- an approach is not selected in the FMC, or
- Glideslope Cancel is selected, or
- the flight path is not within +/- 2 dots of a valid localizer beam or final approach course (excessive ILS, GLS or FMC flightpath deviation), or
- the flight path is not within +/- 2 dots of a valid glideslope or glidepath (excessive ILS, GLS or FMC glidepath deviation)

DH/MDA Callouts

The GPWS provides height callouts based on the altitude set by the Captain's Minimums selector.

- DH/MDA plus 80 feet – APPROACHING MINIMUMS
- at DH/MDA – MINIMUMS or;

- DH/MDA plus 100 feet – APPROACHING DECISION HEIGHT
- at DH/MDA – MINIMUMS

Traffic Alert and Collision Avoidance System (TCAS)

TCAS alerts the crew to possible conflicting traffic. TCAS interrogates operating transponders in other airplanes, tracks the other airplanes by analyzing the transponder replies, and predicts the flight paths and positions. TCAS provides advisory and traffic displays of the other airplanes to the flight crew. Neither advisory, guidance, nor traffic display is provided for other airplanes which do not have operating transponders. TCAS operation is independent of ground–based air traffic control.

To provide advisories, TCAS identifies a three dimensional airspace around the airplane where a high likelihood of traffic conflict exists. The dimensions of this airspace are based upon the closure rate with conflicting traffic.

TCAS equipment interrogates the transponders of other airplanes to determine their range, bearing, and altitude. A traffic advisory (TA) is generated when the other airplane is approximately 40 seconds from the point of closest approach. If the other airplane continues to close, a resolution advisory (RA) is generated when the other airplane is approximately 25 seconds from the point of closest approach. The RA provides aural warning and guidance as well as maneuver guidance to maintain or increase separation from the traffic.

Non–transponder equipped airplanes are invisible to TCAS. RAs can be generated if the other airplane has a mode C transponder. Coordinated RAs require both airplanes to have TCAS.

Advisories and Displays

Annunciations associated with TCAS and the traffic displays are discussed further in Chapter 10.

TAs are indicated by the aural "TRAFFIC, TRAFFIC" which sounds once and is then reset until the next TA occurs. The TRAFFIC annunciation appears on the navigation display. The TA symbol appears at the proper range and relative bearing of the other airplane. Altitude and vertical motion are included with the symbol if the other airplane is using transponder mode S or C.

RAs are indicated by one or more aural listed in the RA aural table. The TRAFFIC annunciation and RA symbol which depicts the traffic's relative bearing, range, altitude, and vertical motion are on the navigation display similar to the TA symbol.

Additional symbols are proximate traffic and other traffic. Proximate traffic is within six miles and 1200 feet vertically, but is not expected to cause a TA or RA alert. Other traffic is beyond the six mile and 1200 feet vertical criteria. Traffic symbols are revised as the TCAS system constantly reevaluates the motion of other airplanes.

If the range of the navigation display does not permit the display of a TA or RA an OFFSCALE annunciation appears on the navigation display.

TA or RA traffic detected by TCAS which do not provide a bearing generate a no–bearing text block beneath the TRAFFIC text on the navigation display. The text block contains distance, altitude, and vertical motion information.

Vertical motion information is indicated by an arrow depicting a climb or descent if a change of greater than 500 feet per minute is detected.

TCAS display automatically shows when:

- the transponder mode selector is in TA ONLY or TA/RA, and
- a TCAS TA or RA occurs, and
- neither pilot has the TCAS (TFC) display selected, and
- in MAP, center MAP, VOR, or APP modes.

Inhibits

INCREASE DESCENT RAs are inhibited below approximately 1,500 feet radio altitude.

DESCEND RAs are inhibited below approximately 1,100 feet radio altitude.

RAs are inhibited below approximately 1,000 feet radio altitude. Below 1,000 feet when the TA/RA mode is selected on the transponder panel, TA only mode is enabled automatically and the TCAS message TA ONLY displays on the ND.

All TCAS voice annunciations are inhibited below approximately 500 feet radio altitude.

All TCAS alerts are inhibited by GPWS and windshear warnings.

Resolution Advisory Aurals

The following table(s) identifies the possible callouts associated with RAs and the vertical restrictions or maneuver recommended in each case.

AURAL ALERTS	VERTICAL RESTRICTIONS/MANEUVER
MONITOR VERTICAL SPEED	Present pitch attitude is outside the RA pitch command area. Keep pitch attitude away from red area.
MAINTAIN VERTICAL SPEED, MAINTAIN	
MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN	
CLIMB, CLIMB	Climb at the displayed pitch
DESCEND, DESCEND	Descend at the displayed pitch
LEVEL OFF, LEVEL OFF	Reduce climb or descent rate to 0 feet per minute.
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	Climb at displayed pitch. Airplane climbs through traffic's altitude.
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	Descend at displayed pitch. Airplane descends through traffic's altitude.
INCREASE CLIMB, INCREASE CLIMB	Increase climb rate from initial pitch attitude.
INCREASE DESCENT, INCREASE DESCENT	Increase descent rate from initial pitch attitude.
CLIMB – CLIMB NOW, CLIMB – CLIMB NOW	Reversal maneuver from initial descent RA.
DESCEND – DESCEND NOW, DESCEND – DESCEND NOW	Reversal maneuver from initial climb RA.
CLEAR OF CONFLICT	RA encounter terminated. Maneuver guidance no longer displayed.

Tail Skid

The tail skid assembly consists of a cartridge assembly, tail skid, fairing (skirt) and shoe. The fairing provides an enclosure for the actual tail skid structure. The shoe is fitted to the bottom of the fairing.

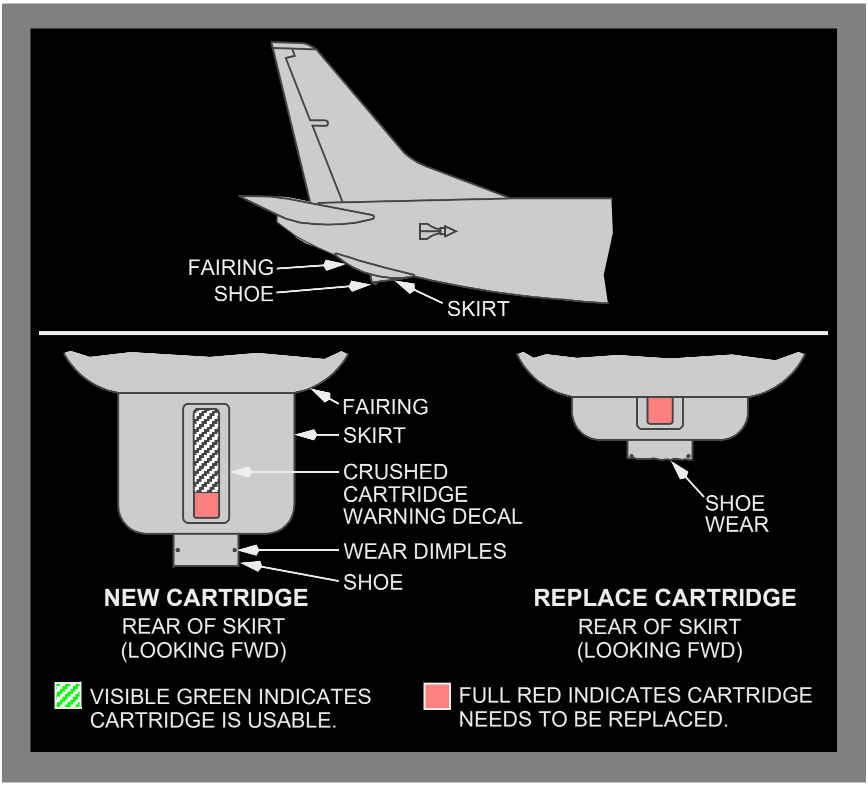
The cartridge assembly consists of a crushable honeycomb material. When the tail skid strikes the runway the skid moves upward and the honeycomb material crushes. The tail skid is serviceable when the cartridge warning decal shows both green and red. The green disappears gradually as the cartridge is crushed. When the warning decal is all red, the cartridge must be replaced.

The shoe is what contacts the runway in the event of an over rotation. The shoe surface displays “wear dimples” which serve as a reference for shoe replacement.

The two-position tail skid (as installed) is powered by hydraulic system A. It is extended for landing and retracted for takeoff.

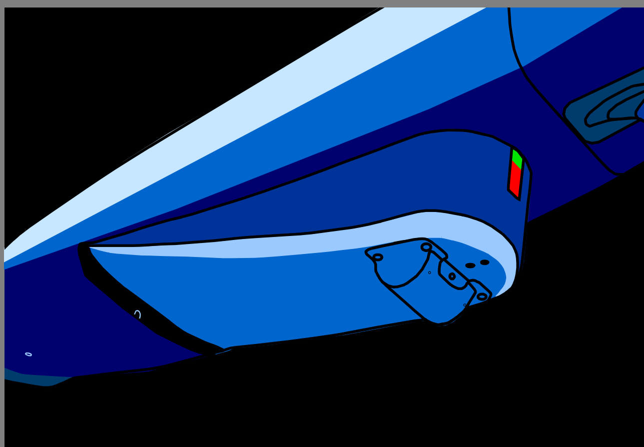
CAUTION: Cartridge assembly warning placard must be checked as soon as possible after the tail strike. The tail skid skirt fairing may re-extend due to gravity as time passes resulting in a reading error on the warning placard decal.

Tail Skid Detail



Two-Position Tail Skid Detail

(As installed)



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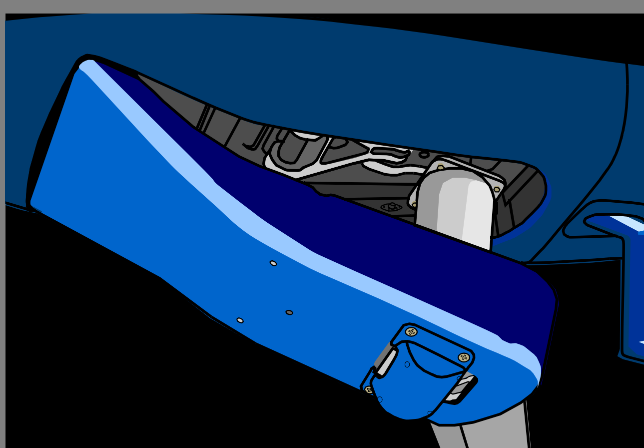

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